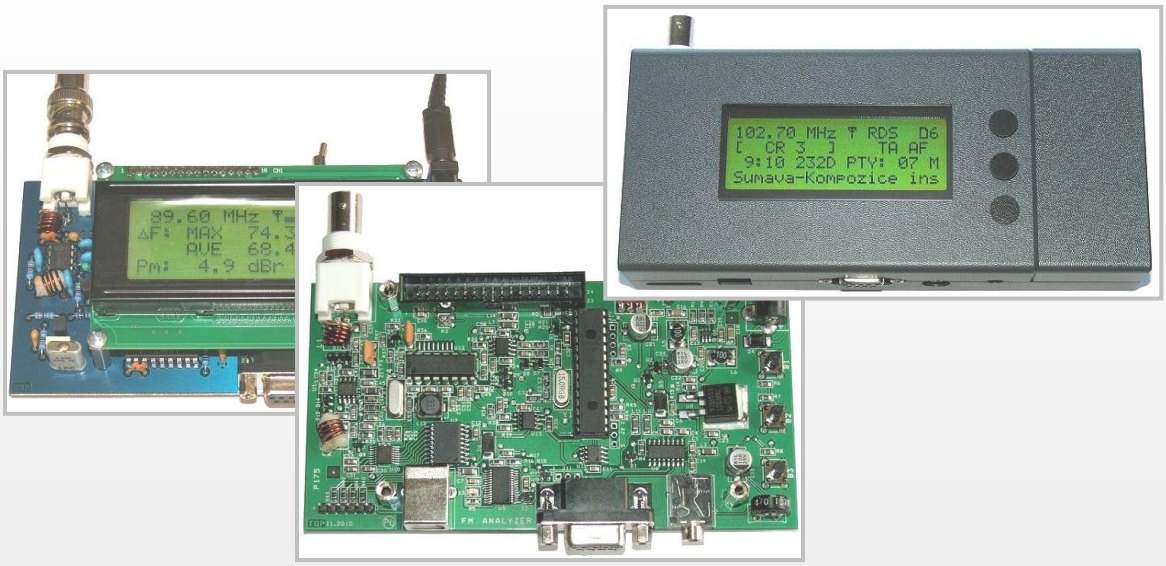


PIRA75 / P175
FM Broadcast Analyzer

User Manual

Version 1.5 rev. 5

Web: http://www.pira.cz E-mail: mail@pira.cz

Table of Contents

Introduction **3**
Main highlights 3
Measurements, indications and outputs 3
Technical Specifications **4**
Power supply (P75) 6
Power supply (P175) 6
Mainboard composition (P75) 7
Mainboard composition (P175) 8
Alarm outputs (P175) 9
Operating Instructions **10**
Power-up 10
Operating modes 10
Menu 10
Measurements **12**
Signal quality 12
Overall frequency deviation (peak frequency deviation) 14
Pilot deviation 14
RDS deviation 14
Pilot-to-RDS phase difference 15
Modulation power (MPX power, P_m) 15
Frequency deviation histogram 16
Service details (P75) 17
Service details (P175) 17
Simple stereo balance meter 17
Carrier frequency offset 18
Radio Data System decoding 19
USB and COM Port Communication **23**
Connecting the FM analyzer to a PC 23
List of commands and configuration registers 23
FM Scope for Windows **28**
Basic features 28
System requirements 28
First steps 28
Connection to the device 29
Preferences 29
DIP switches 30
Tool bar 30
Frequency deviation, histogram and accumulated distribution plot 31
Modulation power 31
MPX 32
RF Carrier 33
Bandscan 35
Station lists 36
Text window 36
Radio Data System / Radio Broadcast Data System 37
FTP upload 38
SMTP Email client 38
MP3 recorder 39
Zoom option 39
Script files 40
Web server 54
Socket control 57
Task scheduler 58
Tips 58
Service Part **59**
Firmware update 59
Superheterodyne receiver ganging 59
Annexes **60**
Memory map 60
SetProperty and ReadProperty options 62

Introduction

The P75 and P175 FM Broadcast Analyzer is a stand-alone low-cost solution for FM broadcast analysis. It provides complete FM modulation and basic AF spectrum measurements in FM radio band through the antenna input.
Built-in LCD display and control interface allows to measure and collect data in terrain without need of any PC computer. Serial interface and the control software provide a possibility of remote control, data viewing and automated data logging.
This kind of analyzer is essential equipment for all FM radio stations to ensure compliance with basic technical broadcast standards and to accomplish the highest audio quality possible.

Main highlights

- Stand-alone design, completely DSP based from IF to outputs
- Compliant with CEPT/ERC REC 54-01 E
- Dual-conversion receiver
- Built-in LCD display and RS-232 interface
- Built-in USB interface (P175)
- Firmware updates are free
- Easy to use

Measurements, indications and outputs

- Overall frequency deviation incl. histogram
- Modulation power (MPX power)
- Baseband spectrum, RF carrier spectrum
- Pilot deviation
- RDS deviation
- Pilot-to-RDS phase difference
- FM carrier frequency offset
- Reception quality and signal strength
- Stereo balance meter
- Headphones audio output
- Alarm logic outputs (P175)
- RDS/RBDS decoder

Please read this entire manual and familiarize yourself with the controls before attempting to use this equipment.

The equipment has been thoroughly tested and found to be in proper operating condition when shipped. The manufacturer is not liable for any damages, including but not limited to, lost profits, lost savings, or other incidental or consequential damages arising out of the use of this product.
No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or information storage and retrieval systems, for any purpose other than the purchaser's personal use.
It is our intention to provide you with the best documentation possible to ensure successful use of the product. If you wish to provide your comments on organization, clarity, subject matter and ways in which our documentation can better serve you, please mail us your comments.
Information in this document is subject to change without notice.

Revision: 2015-11-13
Copyright © 1999-2015 Pira.cz

Technical Specifications

Parameter	Condition	Value
General		
Supply voltage (P75)	external	8 – 16 V DC
	battery	4.8 – 5.8 V DC (4x AA NiMH)
Supply current (P75)	LCD off	170 mA
	LCD on	240 mA
Supply voltage (P175)	external	8 – 12 V DC
	battery	2.3 – 4.5 V DC (2x or 3x AA NiMH)
	USB	5.0 V
Supply current (P175)	LCD off	140 mA
	LCD on	210 mA
	battery	up to 500 mA
External power supply connector		DC 2.1 mm
Board dimensions (P75)		139 x 72 mm
Board dimensions (P175)		133 x 70 mm
CPU		120 MHz RISC DSP
Data connector (P75)		RS-232 (DCE, 9 pins), bidirectional
Data connector (P175)		RS-232 (DCE, 9 pins), bidirectional, USB (FTDI based, virtual serial port)
Communication speed		19200 bps
Communication mode		1 stop bit, 8 data bits, no parity, (no flow control)
RX buffer length		40 bytes
Intermediate frequency (IF)	1st IF	10.675 MHz
	2nd IF	0.325 MHz ± 0.005 MHz
IF bandwidth		280 kHz
Antenna Input		
Antenna connector		BNC, 50 Ohms
Frequency range		87.5 – 108.0 MHz
Tuning step		selectable 50 kHz or 100 kHz
Input sensitivity	S/N 26 dB	4 µV
	basic measurements	30 µV
	full measurements	70 µV
Maximum input level		0.5 V (5 mW)
Intermodulation immunity		basic (single input LC circuit with coil tap)

Never connect RF power output from the transmitter directly to the device's antenna input!

Measurements		
Frequency deviation range	min.	0 – 121 kHz
Frequency deviation error	1 kHz sine	< ± 1.5 kHz
	typical content	< ± 2 kHz
Modulation power range	min.	-12 – 14 dBr
Modulation power error	-6 – 6 dBr	± 0.2 dBr
Pilot deviation error	6.8 kHz	± 0.2 kHz
RDS deviation range		1.0 – 17.9 kHz, note 5
RDS deviation error	full signal	± 5% ± 0.5 kHz
Pilot-to-RDS phase difference error		± 4 deg.
Baseband frequency response flatness	10 Hz – 60 kHz	± 0.3 dB
Stereo balance error		± 0.5 dB
Signal level error (P175)	35 – 86 dBµV	non-linearity ± 3 dBµV, offset ± 2 dBµV
	0 – 35 dBµV	not specified
Alarm Outputs (P175)		
Maximum current from pin 1		100 mA
Maximum current from/to pin 2, 3, 4, 5		15 mA (internally limited by 390R serial resistor)
Headphones Audio Output		
Audio channels		1 (switchable R+L, L, R, R-L)
Output impedance	typ.	100 Ohms
Output level	no load	adjustable 0 – 2.5 V p-p @ 75 kHz
Signal to noise ratio	75 kHz, volume 0 dB	55 dB
Stereo decoder separation	1 kHz	>23 dB
Distortion	1 kHz	2 %
Internal RDS/RBDS Decoder		
RDS groups detected		All RDS groups 0A-15A, 0B-15B
RDS services supported		PS, PI, PTY, PTYN, TP, TA, M/S, DI, AF, EON, ECC, LIC, PIN, RT, CT, AID, RT+
RDS groups decoded		0A, 0B, 1A, 2A, 2B, 3A, 4A, 10A, 14A
RDS deviation (ΔF_{rds}) required	min.	1.0 kHz
Antenna input sensitivity (average BER = 5 % or less, single station, no interference)	ΔF_{rds}=2.0 kHz	30 µV
	ΔF_{rds}=3.4 kHz	18 µV
	ΔF_{rds}=6.8 kHz	9 µV

Never exceed specified voltage value at the battery power supply connector! It may cause permanent damage to the device! Disconnect or remove accumulators from the unit when it is not in use!

Don’t open the plastic cover (boxed versions)! No user adjustable parts inside! Risk of damage!
Take care to avoid strong mechanical pressure on the power switch during transport!
Never use the equipment if there's any visible damage on its electrical parts! In that case disconnect all cables, remove accumulators and contact the vendor or manufacturer.

Notes (Technical specifications):

1. p-p = peak-to-peak value; BER = Block Error Rate
2. Due to inherent reception the unit may have reduced sensitivity at 90.0 MHz.
3. Very strong el. field intensity (above 130 dBµV/m) may cause additional measuring error or may disallow the measurement.
4. Shadowed fields are device specific.
5. If pilot and RDS are not synchronized, the range reduces to 1.7 – 17.9 kHz. Spurious RDS detection may occur on stations without RDS if the station's signal is noisy or specific static sine tones are transmitted. If ARI system is used simultaneously with RDS on the same transmitter, the RDS deviation value should not be taken into consideration. Instead of this the Windows application and MPX spectrum graph gives an image about signal level of each component.

Power supply (P75)

External power supply connector

The FM analyzer can be supplied from any power supply, which delivers a voltage between 8 and 16 V DC and continuous current of 300 mA to 1 A. The FM analyzer has polarity protection and own voltage stabilizer. The central conductor of the power supply connector is positive (+).

Battery power supply connector

Use this connector for supplying the FM analyzer from 4x 1.2V NiMH accumulator or stabilized +5V power supply. This connector is polarity protected.
If both power supply connectors are being used to power the FM analyzer, the external connector has higher priority.
The unit does not charge the battery.

Power supply (P175)

External power supply connector

The FM analyzer can be supplied from external power supply (typically DC wall adapter), which delivers a voltage between 8 and 12 V DC and continuous current of 300 to 500 mA. The FM analyzer has polarity protection and own voltage stabilizer. The central conductor of the power supply connector is positive (+).

Battery power supply connector

Use this connector for supplying the FM analyzer from 2x or 3x 1.2V NiMH accumulator.
Due to safety reasons, the unit does not charge the battery.

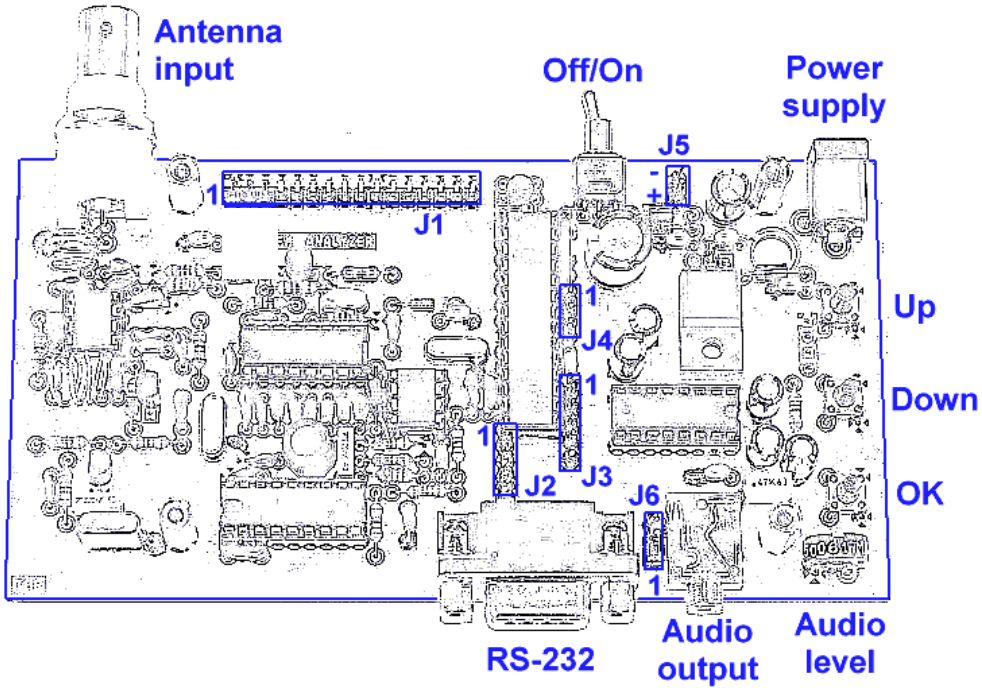
USB connector

Use this connector for supplying the FM analyzer from PC computer or stabilized +5V power supply.
This connector is **not** polarity protected. Connecting an active USB cable the unit is always turned on, i.e. the power off/on switch has no effect if the unit is powered from USB.

Never exceed specified voltage value at this connector! It may cause permanent damage to the device!

The USB port must be rated to full **500 mA** current! When supplying the unit with USB bus, it is a better choice to connect the unit to the USB interface on the main board. Supplies for pocket USB hubs and for some USB interfaces of lap-top and desk top computers are not sufficient and an **external power supply** is necessary!

Mainboard composition (P75)



J1 – LCD display connector (HD44780 standard)

J2 – Expansion IIC bus
1: +5 V
2: SDA
3: SCL
4: Ground

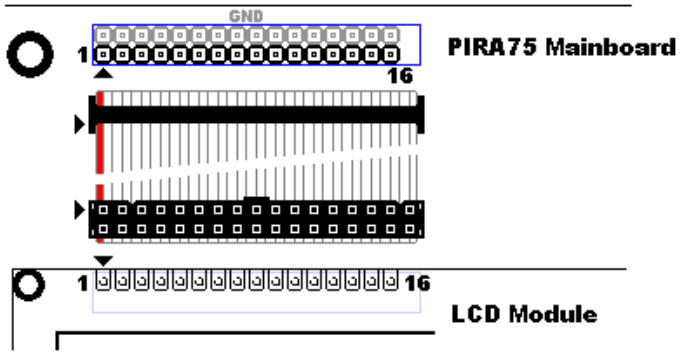
J3 – Reserved for user applications
1: Ground
2: DIP5 output (for remote switching)
3: Reserved
4: Ground
5: +5 V

J4 – Reserved
1: MPX/audio PWM output (no LPF)
2: Receive Data (RxD), TTL
3: Transmit Data (TxD), TTL

J5 – Battery power supply connector

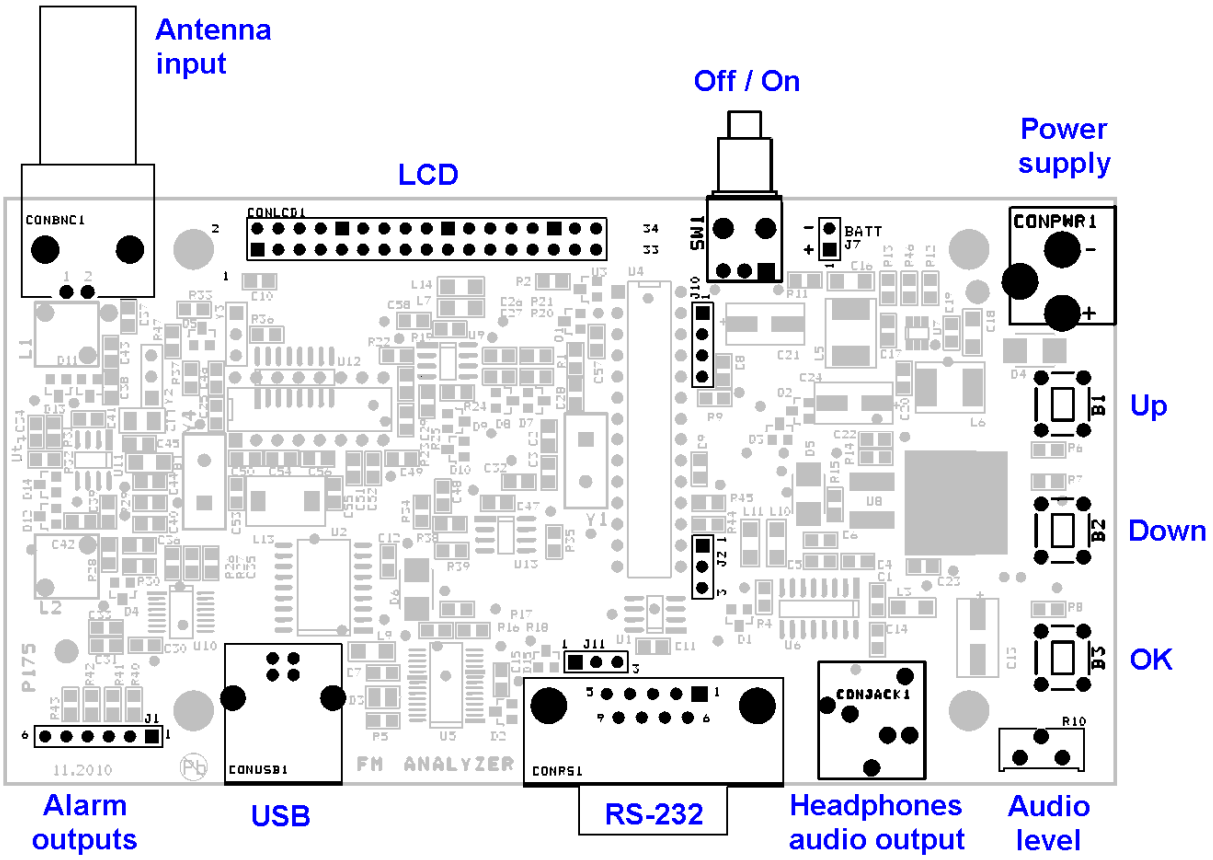
J6 – Audio connector mono/stereo switch
1-2: mono jack
2-3: stereo jack (headphones)
Note: the audio output is still one channel.

LCD module connection (if flat cable is used)



Make sure the LCD module is connected right before connecting power supply!
Incorrect connection will cause permanent damage to the LCD module.

Mainboard composition (P175)



J1 – Alarm outputs / General purpose outputs *
1: +5 V output for powering external device (max. 100 mA)
2: Alarm 1 (Signal lost)
3: Alarm 2 (Silence)
4: Alarm 3 (Overmodulation)
5: Alarm 4 (Pilot or RDS level error)
6: Ground

J2 – Reserved for special applications
1: DIP5 output (for remote switching)
2: Reserved
3: Ground

J7 – Battery power supply connector

J10 – External buttons (pull-up resistors on board)
1: Ground
2: Up
3: Down
4: OK

J11 – Serial RS-232 port (TTL levels)
1: Receive Data (RxD)
2: Transmit Data (TxD)
3: Ground

** Notes:*
The Alarm outputs can be used as independent general purpose logical outputs. See the section "List of commands and configuration registers" for more details.
Maximum current from/to pins 2-5 is limited by internal 390R serial resistors.

Note: The device provides three serial communication ports (USB, RS-232 and J11). These ports are internally linked together so the user may select any of these ports that best fits the communication requirements. When requesting data via any port, all ports will send the reply. The user must ensure that different ports will not receive requests at the same time.

Note for boxed version: There are no user-adjustable elements inside! Don't remove the front panel!

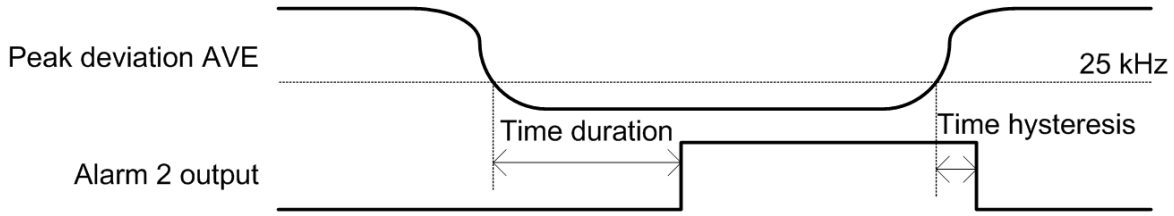
Alarm outputs (P175)

The device provides four independent logic outputs that are set by specific alarm conditions. These outputs can be used for direct LED driving, switching to backup transmission equipment, signalizing via GSM gateway etc.

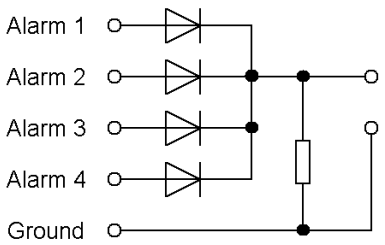
The alarm outputs are active high. If the alarm condition is no longer actual, appropriate output is driven low when the time hysteresis elapses. Almost all parameters are user configurable. With factory default values the alarm behavior is as showed in this table:

Alarm output	**Condition**	**Interpretation**
Alarm 1: Signal lost	Signal quality < 4 (time duration 30 seconds)	FM transmitter failure or signal for the P175 device is too weak for permanent monitoring.
Alarm 2: Silence	ΔF AVE < 25 kHz (time duration 1 minute)	There's no audio or the audio level is too low. Broadcast automation system has crashed or studio's mixing console has been set improperly or connection between studio and transmitter has been lost.
Alarm 3: Overmodulation	ΔF MAX Hold > 88 kHz and [Histogram Max At > 78 kHz or ΔF AVE > 78 kHz] (time duration 1 minute)	Transmitter problem or sound processing problem or unauthorized manipulation with the broadcast equipment or signal too bad (alarm 1 interpretation may apply).
Alarm 4: Pilot or RDS level error	ΔF Pilot < 5.8 kHz or ΔF Pilot > 7.7 kHz or ΔF RDS > 8.5 kHz (time duration 1 minute)	Stereo encoder fault or transmitter problem or unauthorized manipulation with the broadcast equipment.

The device must operate in Measuring mode otherwise alarms are deactivated and the outputs are driven low. The user must ensure that the device will receive the station's signal in appropriate quality. To resume the monitoring on desired frequency automatically after eventual power drop out, save the settings using menu item 4. To configure the alarms see the section 'USB and COM Port Communication'.



Alarm response example.



Application example – Logical sum (OR function) of alarm outputs.

Operating Instructions

Power-up

Make sure the unit is switched off. Connect the power supply and then switch the unit on. The device requires no heating time. After a few seconds the unit is ready for operate. The antenna, audio and data cables can be connected regardless of the operating state.

Control buttons

Button	Symbolic meaning	Meaning
	↗	Go to next page or menu item, tune up.
	↙	Go to previous page or menu item, tune down.
	●	OK, enter the menu, confirm or change the option.

Operating modes

Measuring ON		
Measuring OFF	RDS decoder mode	
	Stereo decoder mode	*L*
		R
		L-R
		L+R

The mode selected is indicated at the first line of the LCD. When switching between the modes, the values measured will remain. The stereo decoder modes affect the audio signal in headphones output. This output is one-channel.

Menu

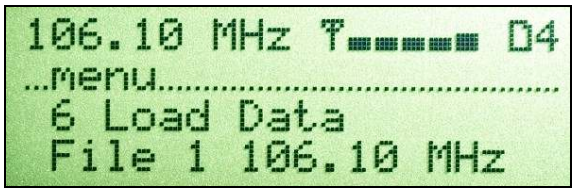
To enter the menu, press the OK button. Some items are showed depending upon context (page or operating mode).

Menu item	Meaning
1 – Tune	Tune to a desired frequency in FM band (manual tuning)
2 – Scan	Tune using a scan mode (automatic tuning, stops on each station).
3 – Histogram Data 3 – Set as Normal 3 – More RDS Data	Show frequency deviation histogram values. Consider the 2nd IF as a normal (see Carrier frequency offset) Show more Radio Data System information.
4 – Save Settings	Save settings (incl. actual frequency tuned)
5 – Save Data	Save measured data and RDS data into EEPROM.
6 – Load Data	Load measured data and RDS data from EEPROM.
7 – Clear Data	Clear all measured values in operational memory.
8 – Volume	Adjust audio volume in steps.
9 – Sending Pm 9 – Mode	Enable/Disable sending of modulation power values via serial port if measuring is enabled. Set the operating mode if measuring is OFF: RDS, Stereo L, R, L-R, L+R.
10 – Measuring	Enable/Disable the measuring.
11 – Return	Return from the menu.

Save Data

The FM analyzer can store data from up to 4 (P75) or 30 (P175) measurements into internal EEPROM memory. This memory does not lose the data after power-off.
Select the Save data menu item and choose unused file position (or rewrite any actual position).
In addition actual frequency and these RDS information are saved: PS, PI, PTY, TP, TA, M/S, RT (P175), EON, AF, DI, group statistics.
The Save Data feature also supplies a preset memory function for tuning frequencies.

Load Data

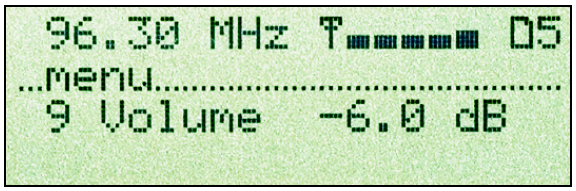


Select the Load data menu item and choose the file required. The data are identified by the frequency.

To use the file as a frequency preset:
- Make sure the device operates in Measuring or RDS mode
- Load the file

To use the file for the purpose of reading all stored data:
- Make sure the device is set to Stereo decoding mode
- Load the file
- You may browse the data, send them via serial port or continue in measurement by enabling the Measuring option in menu.

Headphones output volume



The menu item 9 allows adjusting of audio volume in steps. Fine adjust or max. level adjust is made using the on-board control.

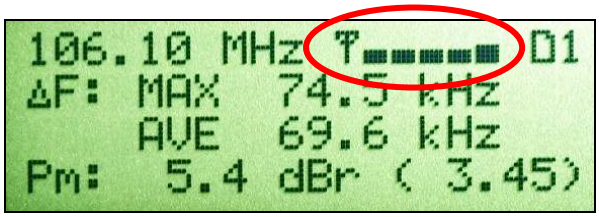
Note: The headphones output is not suitable for rebroadcast or streaming purposes.

Low battery indication

When the accumulator voltage drops below 4.7 V (P75) or 2.3 V (P175) or when the external power supply voltage drops below 6.9 V, the “BATT” indicator is showed. The device will not stop the operation by force; it allows the user to continue in their work. It’s on the user’s responsibility to finish the measurement and switch the unit off as soon as possible. Disregard for the low battery indicator may result in data loss and accumulator damage!

Measurements

Signal quality



The signal quality indication does not reflect the signal strength directly. It's a result of the following input parameters and influences:

- Noise level (measured in baseband above 100 kHz)
- Multipath propagation
- Intermodulation
- Amplitude ripple (AM modulation)
- 2nd IF frequency (frequency offset) – "in-channel" check

The essential condition for the measurement is enough signal level on the antenna input and sufficient frequency spacing between the stations. Not all signals that you can listen can be also measured. The following scale illustrates it and it's valid generally:

Signal level	1 µV	10 µV	100 µV	1000 µV
Reception on typical receiver	Mono only	Poor quality stereo	High quality stereo	
Measurement ability	Not possible	Basic	Full	

The basic measurement includes modulation power, pilot level and RDS decoding. The full measurement includes overall frequency deviation and RDS level. In noisy environment or in a location with many strong stations the minimum signal level may increase.

It's possible to say that optimal signal strength range and reception conditions for full measurement coincide with the requirements placed on high quality stereo reception. This rule determines the demands closely.

Signal reception quality table:

Signal	**Meaning**
	No signal.
■	Weak noisy signal detected.
■■	Signal unusable for measurement.
■■■	Poor signal. Basic measurement is possible with reduced precision for RDS level. Full measurement is not possible.
■■■■	Good signal. Full measurement is possible with partially reduced precision.
■■■■■	Excellent signal.

Note: For proper measurement of modulation characteristics, internal bandwidth for RF signal is fixed at 280 kHz. In locations where stations are present in 200 kHz or even 100 kHz spacing, the device may indicate insufficient signal quality unless signal of the adjacent stations is rejected enough by positioning of the receiving antenna.

Following tables illustrate approximate max. measuring distance as a result of transmitter's ERP power and measuring conditions:

Estate housing, telescopical antenna:

ERP	Max. distance
1 W	300 m
10 W	800 m
100 W	3 km
1 kW	8 km
10 kW	20 km
100 kW	40 km

Open space, hill, Yagi antenna:

ERP	Max. distance
1 W	800 m
10 W	3 km
100 W	7 km
1 kW	20 km
10 kW	50 km
100 kW	100 km

Baseband noise spectrum from the area around 100 kHz is mirrored to audio spectrum in the audio output. This results in audible noise expansion and helps to find the best antenna position if the input signal is weak.

Selecting an antenna

There is no generally valid choice for the antenna. The requirements for the antenna differ with local conditions and kind of use. The essential condition for the measurement is enough signal level of the desired station on the antenna input. Not all signals that you can listen on any radio receiver can be also measured. It's possible to say that optimal signal strength range for full measurement coincides with the range which is required for high quality stereo reception. From this observation it's clear that simple telescopic or whip antennas are not enough for some applications. On the other hand special calibrated antennas for EMI and RF field applications have no reason for FM modulation measurements.
In the transmitter's near field (up to 1 km distance from the transmitter) any piece of wire connected to the antenna input should be always sufficient. When measuring other than only local stations or where number of stations reaches a couple of tens, a single dipole or 3-element Yagi antenna will give considerably better results than simple telescopic or whip antenna. In many cases this kind of antenna must allow positioning in horizontal plane in order to boost signal of stations of interest and reduce signal of all other stations.
Always make sure there is no pulse interference source near the antenna. These sources especially include computers, cars, electric motors, PWM regulators, high voltage lines etc. Assure stable antenna position during the measurement. Especially the frequency deviation should not be measured in motion like in ridden car.

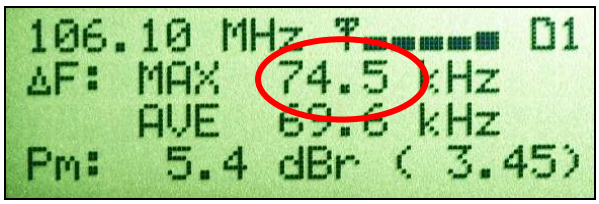
Hint: Keep on mind that with fixed omni-directional antenna, the number of stations with excellent reception (full measurement ability) usually does not exceed 15, regardless of how many strong stations are on air overall in the location. This is caused due to multipath propagation of many station signals, as well as by the receiver's limited selectivity (restricted by requirement of proper FM deviation measurement) and intermodulation predisposition of the receiver's simple front-end. If the station of interest is 30 dB or more below the strongest stations, finding the best antenna position may be necessary to reduce this ratio and to ensure full measurement ability.

Measurement using the transmitter's test RF output

Many FM broadcast transmitters are equipped with a test RF output. This output is primarily not intended for modulation characteristics measurement using an analyzer based on a receiver as the P75/P175 device is. In most cases it can be used for this purpose but this usually does not bring any advantage. Special care is required before connecting the analyzer to this output. Make sure the output signal power does not exceed 5 mW (7 dBm). In some cases the test RF output gives 30 dBm (1 W) or more. This signal must be attenuated to less than 5 mW before connecting to the analyzer!
In our opinion it is better not to use the test output and get the signal "from air". The modulation characteristics are not affected in near field. Another recommended way is to connect only the transmitter's and analyzer's ground (shielding).
On the transmitter sites where many transmitters are operating the user may be forced to find one of the methods mentioned that gives full quality result. It's due to intermodulations caused by many strong signals and their harmonics that are present in this environment.

Overall frequency deviation (peak frequency deviation)

Frequency deviation (ΔF) is used in FM radio to describe the maximum (peak) instantaneous difference between an FM modulated carrier frequency, and the nominal carrier frequency.



The overall peak frequency deviation shall not exceed **75 kHz**.

The peak hold values of the deviation are taken during a measuring time of 50 ms, 20 times per one second. From this array of values the MAX, AVE and MIN values are calculated and showed. These values represent signal characteristics in last second. The measurement is fully **continuous** over the signal, without any gaps. Moreover, MIN Hold and MAX Hold functions are provided. The MAX Hold value represents the maximum deviation found in last 10 seconds. Since it may be affected by pulse interference, interpret it very carefully. **Remember that any "Hold" or "MAX" function based on a single number cannot fully and adequately describe the FM modulation characteristics as a histogram function can (described thereinafter).**

Pilot deviation

In FM stereo broadcasting, a pilot tone of 19 kHz indicates that there is stereophonic information. The receiver doubles the frequency of the pilot tone and uses it as a phase reference to demodulate the stereo information. The (L+R) main channel signal is transmitted as baseband audio in the range of 30 Hz to 15 kHz. The (L-R) subchannel signal is modulated onto a 38 kHz subcarrier occupying the baseband range of 23 to 53 kHz.

The deviation range of the FM carrier caused by pilot tone is from **6.0 kHz** to **7.5 kHz**. The recommended value is **6.8 kHz**.

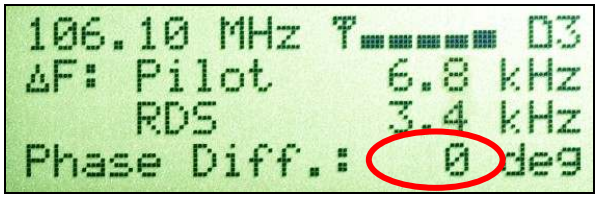
RDS deviation

Radio Data System (RDS), is a standard from the European Broadcasting Union for sending small amounts of digital information using conventional FM radio broadcasts. Radio Broadcast Data System (RBDS) is the official name used for the U.S. version of RDS. The two standards are nearly identical, with only slight differences. Both use a 57 kHz subcarrier to carry data.

The deviation range of the FM carrier caused by RDS/RBDS is from **1.0 kHz** to **7.5 kHz**. The most used value is around **3.0 kHz**. This value should be considered as a minimum if dynamic PS or TMC is used.

Pilot-to-RDS phase difference

The 57 kHz for RDS subcarrier was chosen for being the third harmonic of the pilot tone for FM stereo, so it would not cause interference or intermodulation with it. The amount by which RDS subcarrier and third harmonic of pilot tone are out of step with each other can be expressed in degrees from 0° to 360°. Since the RDS signal is based on its carrier phase alternating, the full angle reduces to straight angle and we can equate 90 degrees = -90 degrees.



During stereo broadcasts the RDS subcarrier will be locked either in phase (**0 degrees**) or in quadrature (**90 or -90 degrees**) to the third harmonic of the pilot-tone. The tolerance on this phase angle is **±10 degrees**.

A value out of the specification is however not to be considered as a critical failure, i.e. there's no need to solve that situation promptly.

If no value is given, the RDS and pilot are not in stable phase relation. In that case check if pilot or MPX signal is connected to the RDS encoder input and external synchronization is enabled. Follow the instructions supplied with your transmission equipment.

Set the phase difference when the transmission equipment works under common conditions and after enough time of warm-up. The phase difference depends a little on the transmission equipment temperature and other physical quantities.

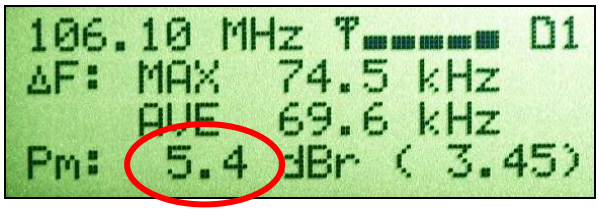
Modulation power (MPX power, P_m)

The modulation power is a relative power of the MPX signal averaged over 60 seconds according to the formula:

modulation power = $10 \log \{(2/60\ s) \int(\Delta f(t)/19\ kHz)^2\ dt\}$ [dBr]

0 dBr corresponds to an average power of a signal equivalent to the power of a sinusoidal tone which causes a peak deviation of 19 kHz.

Intensive audio dynamics compression as well as increasing overall peak deviation causes the modulation power to rise.



The modulation power limit, if defined in your country, is usually **0 dBr** or **+3 dBr**. Please refer to your local communications authority for more information.

Since the modulation power is averaged over last 60 seconds, first value can appear after one minute from power-up or tuning to a new frequency. However the analyzer reduces this time using estimation method during first minute so it shows an estimated value of the modulation power almost immediately, saving considerably the operator's time but still keeping compliance with standards. This is indicated by the 'Pm:' symbol blinking. Relevancy and accuracy of the modulation power value increases with each second. After the first minute elapses, the value is accurate from this moment and the 'Pm:' symbol stops blinking.

The measurement should represent typical modulation of the programme material of the broadcasting station. The observation time should be at least 15 minutes or in some cases one hour may be required to be sure to measure representative programme material.

The value in (...) is a linear representation of the modulation power, 0 dBr = 1.00.

Frequency deviation histogram

To provide more information the deviation is better represented by histogram rather than only displaying the highest value in over a certain period of time. In this device the histogram of frequency deviation is processed as follows:

a) Obtain **N peak hold values (samples)** of the deviation each taken during a measuring time of **50 ms**. The measuring time has influence on the distribution plot and hence must be standardised in order to ensure repeatability. The 50 ms ensures that the peak values of the deviation are captured even at modulating frequencies as low as 20 Hz.

b) Discard the samples that have been taken in presence of noise or interference.

c) Divide the range of frequency deviation of interest (0 – 120 kHz) into 1 kHz resolution to give relevant number of bins.

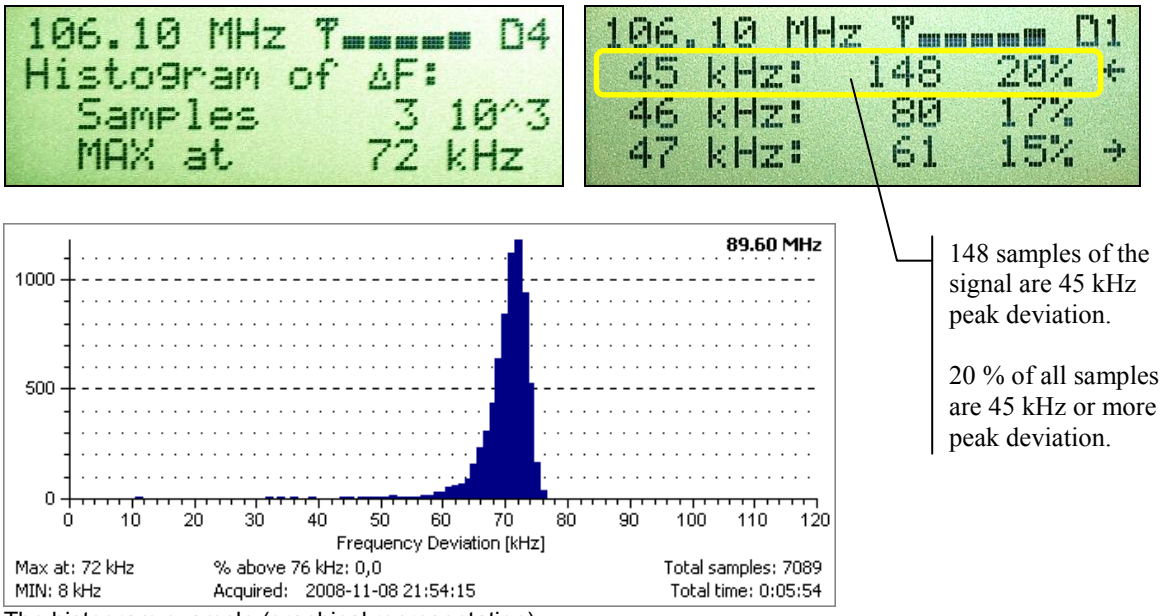
d) For each bin, count the number of samples which have a value within the bin. The result is a distribution plot of the deviation – frequency deviation histogram (see the figure below).

e) Add counts in each bin from left to right and normalise by N. The result is a plot of the accumulated distribution which starts with a probability of 100 % from the lowest deviation and will finish with a probability of 0 % at the highest deviation.

The measurement should represent typical modulation of the programme material of the broadcasting station. The observation time should be at least 15 minutes or in some cases one hour may be required to be sure to measure representative programme material.

Note: Samples associated with a deviation of 121 kHz represent all values above 120 kHz.

Note: Samples are added to the histogram only when the signal quality ensures that the values measured have a sense. This extends the histogram readability in the cases the reception quality is not good enough.



The histogram example (graphical representation).

Service details (P75)

Several service values are provided on the page 5:

The Signal value has two main reasons:

- In production / service process: To adjust antenna input circuitry and trace the signal path.
- During measurements: To find the best antenna position (strongest signal) resulting in the best suppression of pulse interference (as recommended for peak deviation measurements).

The Signal value becomes zero when the input level drops below 100 µV, while the maximum Signal value is reached when input level is about 2 mV.

Use of the 2nd IF parameter is described on following page.

The Noise Level is an output of the internal digital demodulation process telling how much energy is above 100 kHz in the demodulated signal. It's used as a main indicator of the signal quality.

The user should awake to the fact that the Signal and Noise Level values are dimensionless variables. Comparing these values makes no sense. They do not evaluate the original signal but the reception quality in the actual place and using actual antenna and equipment.

Service details (P175)

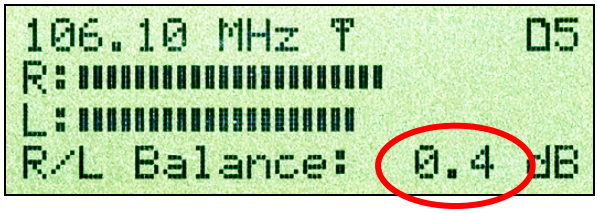
The same information applies as above except for following:

- The Signal represents real signal level on the device input in dBµV unit. Values 0 to 35 dBµV are estimated from the noise level, thus precision is not defined in this range.
- There's an additional peak amplitude modulation indicator. The AM on the received signal may occur for various reasons, including but not limited to transmitter failure, broadcast antenna coupler, motion, interference, multipath propagation and other characteristics of the environment. In general the AM modulation of the signal is undesirable. Thus whenever possible the user should choose such antenna placement and direction that maintains a low or zero AM level. AM below 15 % has usually no effect on the measurement.

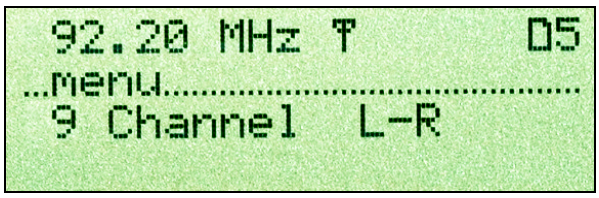
Simple stereo balance meter

To activate the stereo decoder, disable Measuring first. Set the Mode to any of the four Stereo options.

The simple stereo balance meter helps to maintain the same peak signal level in both right and left audio channels if stereo encoder is present in the transmission chain. The best value is around 0 dB (1:1). No special audio signal is required to be broadcasted but it’s preferable to use a sample with no stereo information.



The menu item 9 determines which audio channel will be present on the audio output. You may choose from L+R, L, R and L-R. The L-R channel can help to find the best channel balance as well. If monaural audio sample is being broadcasted, the best balance corresponds with no audio in the L-R channel.



In common operation, the L-R channel may be affected by distortion produced by audio processing. There is also strong “karaoke” effect present.

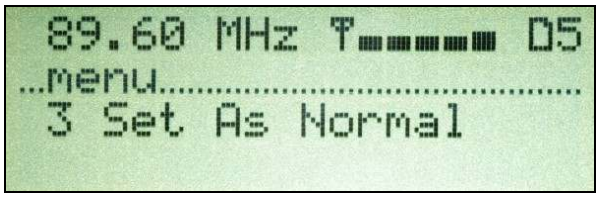
Carrier frequency offset

The unit can provide a relative carrier frequency offset from the nominal frequency. Although there is no calibrated frequency normal included for this purpose, it can be simply found in the band. If any station can be considered as a frequency etalon, the unit can be used to adjust right carrier frequency on the transmitter with 0.1 kHz precision.

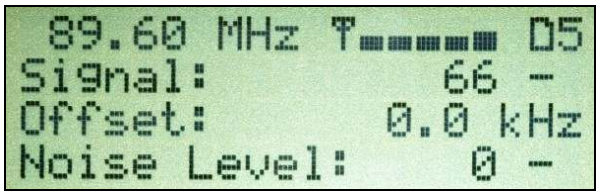
To determine the carrier frequency offset

Under normal conditions the page 5 shows second IF frequency:

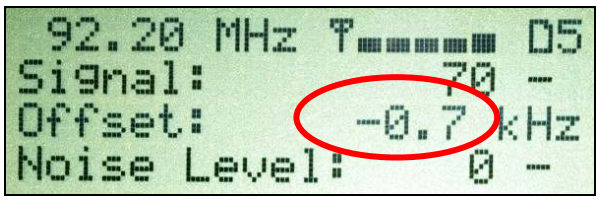
Now select menu item 3:



The Offset value appears which is 0.0 on the station selected as Normal:



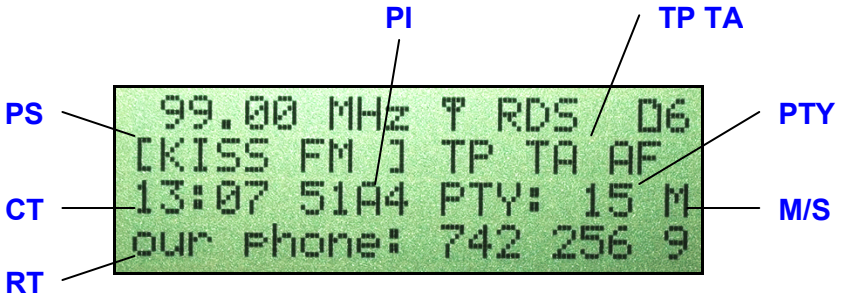
Now tune to any other station:



Still not sure how to read the result of this example? If real frequency of the station at 89.6 MHz is exact, real frequency of the station at 92.2 MHz has -0.7 kHz offset so its exact value is 91.1993 MHz

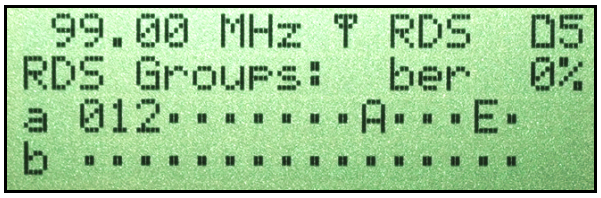
Radio Data System decoding

To activate the RDS decoder, disable Measuring first. Set the Mode to RDS. Page 6 shows the basic RDS information:

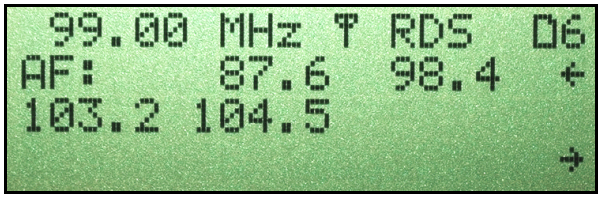


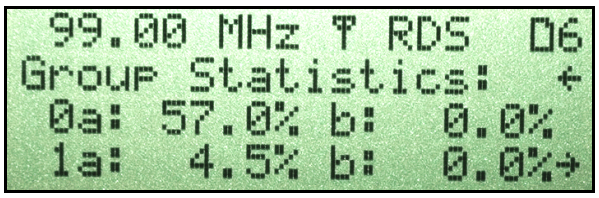
If RT+ service is being broadcast, the RT line contains [ ] symbols indicating begin and end of each RT+ tag in the text. More information is provided on RDS sub-page 15.

When the RDS decoder is active, page 5 shows block error rate (ber) and indicates RDS groups that are being received. This gives quick survey of the RDS services present in the RDS stream. The group numbers are in hexadecimal representation:



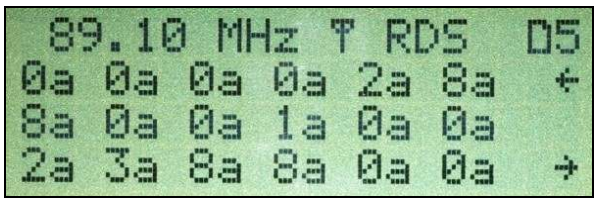
Detailed RDS information is accessible from page 5 or 6 under the menu item 3 (More RDS Data). Total 48 sub-pages are provided. Last 32 sub-pages are reserved for group content viewer.





Group order viewer

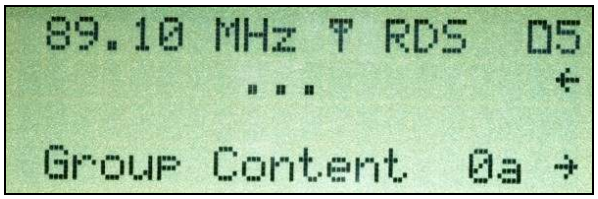
When you access the Group order sub-page, internal group order buffer starts filling. The group order buffer capacity is 18 groups. The group order is showed after about 2 seconds and locked for viewing.

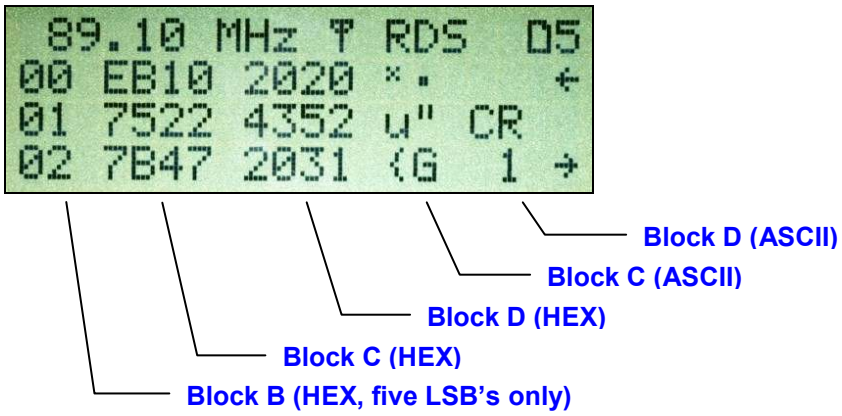


Read the group order line per line. To view actual group order again, go to previous or next sub-page and then back.

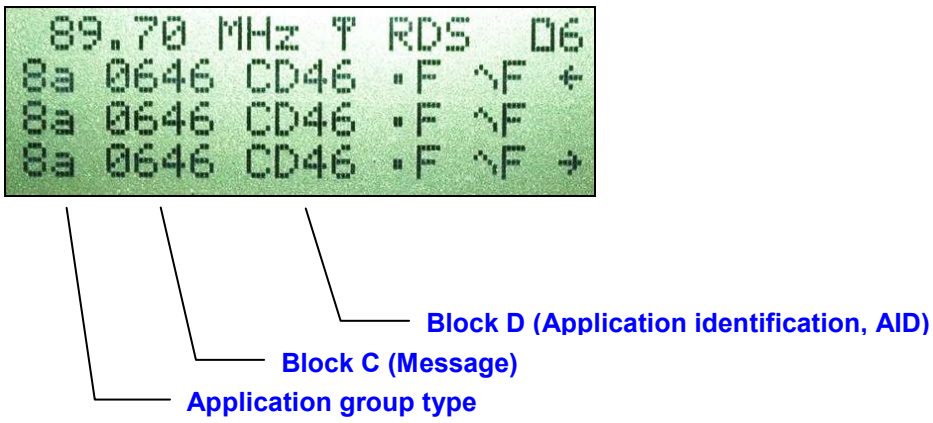
Group content viewer

When you access any Group content sub-page, the group content is showed on each error-less reception of the group type desired. After reception of 3 groups the process is locked for viewing. To view actual group content of the desired group type again, go to previous or next sub-page and then back. The content does not stay in memory.





Special case is group type **3a** (ODA AID) where application group type is directly showed:



More RDS Data summary

Sub-page	Service / Function
1	Detailed PTY, PTYN
2	EON (PI of other networks), ECC, LIC
3	RT type (A/B), actual RT
4	DI
5-7	AF list
8-13	Group statistics
14	CT, PIN
15	Static PS, actual RT+ markers (running, toggle, type1, start1, length1, type2, start2, length2)
16	Group order
17	Group content 0a
18	Group content 0b
...	...
23	Group content 3a (ODA AID)
...	...
48	Group content 15b

List of RDS services

RDS Service	Decoded by the device	RDS Groups
PI (Program Identification)	yes	All
PTY (Program Type)	yes	All
TP (Traffic Program)	yes	All
TA (Traffic Announcement)	yes	0a, 0b, 15b
M/S (Music/Speech)	yes	0a, 0b, 15b
DI (Decoder Identification)	yes	0a, 0b, 15b
PS (Program Service)	yes	0a, 0b
AF (Alternative Frequencies)	yes	0a
ECC (Extended Country Code)	yes	1a
PIN (Program Item Number)	yes	1a
LIC (Language Identification Code)	yes	1a
RT (Radiotext)	yes	2a, 2b
CT (Clock-Time and date)	yes	4a
PTYN (Program Type Name)	yes	10a
EON (Enhanced Other Networks)	yes (PI)	14a, 14b
AID (Application Identification)	yes	3a
RT+ (Radiotext Plus)	yes	3a, 2a, 2b (note 1)
TDC (Transparent Data Channels)		5a, 5b
IH (In-house Applications)		6a, 6b
RP (Radio Paging)		7a, 13a
TMC (Traffic Message Channel)		3a, 8a (note 2)
EWS (Emergency Warning Systems)		9a

Notes:
1) Does not include the group with tags that is defined in AID group 3a.
2) This is the most frequent group type used for TMC. An indication in the AID group 3a is decisive.

List of ODA applications

AID	Application name
125F	I-FM-RDS for Fixed and Mobile devices
1C68	ITIS In-vehicle database
4BD7	RT Plus
5757	Personal weather station
6552	Enhanced RadioText / eRT
7373	Enhanced early warning system
C350	NRSC Song title and artist
C3B0	iTunes tagging
C3C3	Traffic Plus
C4D4	eEAS
C737	Utility Message Channel
CD46	TMC
E123	APS Gateway
E1C1	Action code
E411	Beacon downlink

Notes:
This is not a complete ODA registration list reference.
Some applications are special purpose only or are used very rarely and may require special receiver.

The most frequent RDS setting errors

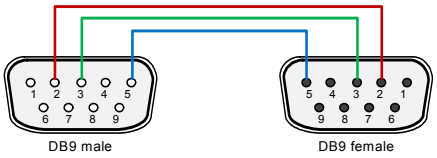
Error	Implication	Solution
First PI digit is 0 (zero).	RDS is not working on some receivers.	First PI digit can't be 0. It should be set in accordance with the country where the station is located.
Two different stations have the same last two PI digits, for example 5AFF and 51FF.	Car radios switch between different stations oneself.	Stations that carry different program entire day must be unambiguously identified by the last two PI digits.
AF list contains more frequencies but second PI digit is 0, for example 603B.	Many receivers ignore the AF list and listener must tune manually to the strongest frequency.	The second PI digit can't be 0 if the station has more transmitters listed in AF.
The station uses only one transmitter but second PI digit is not 0, for example FFFF.	Car radios search for another frequency using PI seek, this takes up to one minute, of course without any result.	The second PI digit must be 0 if the station has only one transmitter (local station).

USB and COM Port Communication

Connecting the FM analyzer to a PC

For configuration and control requirements a PC is connected to the FM analyzer via standard RS-232 interface provided by D-SUB9 female connector (DCE) on the FM analyzer side. On the PC side locate an unused COM port. If the free port exists in a form of 25-pin connector, use a standard D-SUB9 (male) to D-SUB25 (female) adapter. It's preferable to use standard modem serial cable with one male and one female connector. Any USB to RS-232 adapter can be also used.
The P175 version allows direct USB connection. Using appropriate drivers the device will appear as a new COM port in the system so the method of software access is the same for both the RS-232 or USB connections.

FM analyzer	PC
2 (TxD)	2 (RxD)
3 (RxD)	3 (TxD)
5 (GND)	5 (GND)



Configure the communication parameters as follows:

Transmission speed	19200 bps
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Parity checking	*No*
Carrier detection	*No*

List of commands and configuration registers

Note 1: There is no need to validate the commands by any additional character or key, such as <Enter>.
Note 2: Some commands have their equivalent in the FM analyzer's menu.

Command	Meaning
*+	Tune up (one step).
*-	Tune down (one step).
*P	Switch on the modulation power sending.
*p	Switch off the modulation power sending.
*M	Switch on the MAX value sending.
*m	Switch off the MAX value sending.
*R	Switch on RDS groups content sending
*r	Switch off RDS groups content sending
*F	Tune to a frequency entered in kHz. Example (tune to 96.2 MHz): 096200*F
*S	Save settings to EEPROM, incl. DIP switches and alarm registers
*E	Set the unit to measuring mode
*D	Set the unit to RDS decoding mode
*B	Set the unit to stereo decoding mode
*L	Load station data saved in EEPROM memory. Example (load file 3): 03*L
*C	Clear data.

RESET*X	Hardware reset.
DIPx:y*X	Set DIP switch. Example (set tuning step to 100 kHz): DIP2:1*X
ARx:yy*X	Set alarm register. Example (set silence detector threshold to 25 kHz): ARA:25*X
*1 to *6	Switch the LCD view to page 1 to 6.
*0	Activate the LCD backlight.

Commands returning value

Command	Meaning
?B	Return all basic data.
?F	Return actual receiver frequency.
?R	Return the RDS deviation value.
?L	Return the pilot deviation value.
?P	Return actual modulation power value.
?M	Return actual frequency deviation MAX value.
?A	Return actual frequency deviation AVE value.
?N	Return actual frequency deviation MIN value.
?O	Return actual frequency deviation MIN Hold value.
?Q	Return the signal quality (0-5).
?D	Return RDS data.
?T	Return RDS group statistics.
?E	Return the pilot-to-RDS phase difference.
?G	Return the signal information (strength, IF, noise).
?H	Return the frequency deviation histogram data.
?I	Return the 2nd IF.
?C	Return the channel balance (Hz*100/Hz*100, stereo mode only).
?X	Return actual frequency deviation MAX Hold value.
?S	Return actual FFT data.
?U	Return signal level (P175 only)
?V	Return firmware version. No response: version 1.3a or older 1: version 1.3b, 2: version 1.3c, 3: version 1.4, 4: version 1.5
?a	Return address content in ASCII format. Syntax: (address),(length)?a Example (return actual radiotext): 19C,040?a
?h	Return address content in HEX format. Syntax: (address),(length)?h Example (return actual PI): 032,002?h

Note:
See annexes for commented memory map.

DIP switches

	Meaning	0	1		Meaning	0	1
DIP0	LCD backlight	Auto	Manual	**DIP1**	Manual LCD backlight	Off	On
DIP2	Tuning step	50 kHz	100 kHz	**DIP3**	Scan sensitivity	Low	High
DIP4	Optional LED bargraph hardware installed	**No**	Yes	**DIP5**	J3 pin 2 state (P75) J2 pin 1 state (P175)	0	1
DIP6	Noise cancellation between stations	Off	On				

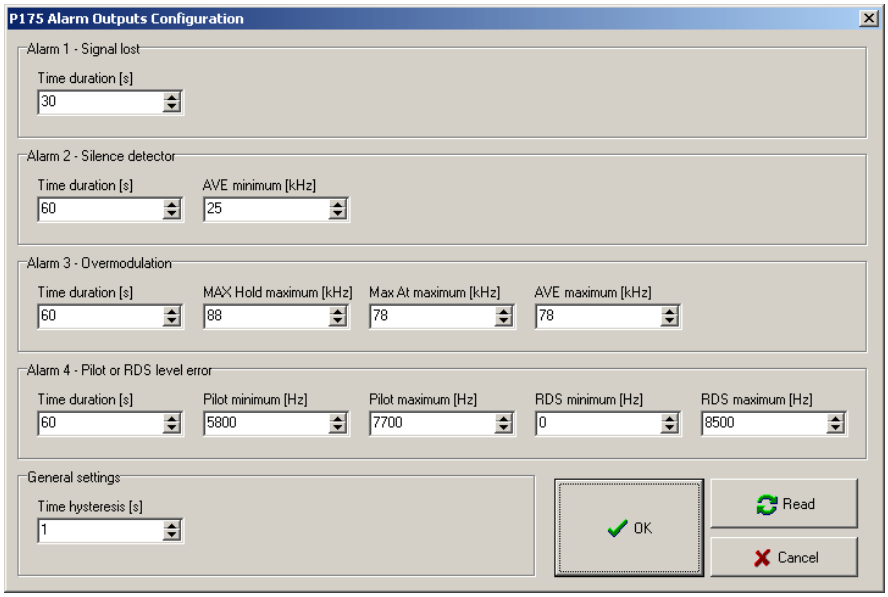
Note:
By default, all DIP switches are set to 0 except for DIP2.

Alarm registers (P175)

Register	Meaning	Default value	Unit
A	Silence detector ΔF AVE minimum	25	kHz
B	Overmodulation ΔF MAX Hold maximum	88	kHz
C	Overmodulation Histogram MAX At maximum	78	kHz
D	Overmodulation ΔF AVE maximum	78	kHz
E	Pilot minimum	58	kHz/10
F	Pilot maximum	77	kHz/10
G	RDS minimum	00	kHz/10
H	RDS maximum	85	kHz/10
I	Signal lost time duration	03	s*10
J	Silence time duration	06	s*10
K	Overmodulation time duration	06	s*10
L	Pilot or RDS error time duration	06	s*10
M	Alarm time hysteresis (common to all alarms)	01	s
N	(Reserved – currently it may be used to store any value)	00	-

Notes (Alarm registers):

1. The alarm registers value range is 00 to 99 (DEC).
2. The built-in alarm feature works independently from any alarms realized in the Windows control software.
3. Due to characteristics of common radio signals it is not recommended to set very short time duration and very long time hysteresis.
4. For user-interactive setting of the alarm feature use the Windows FM Scope application.
   Select Options – Alarm Outputs in the main menu:



To store the settings to a non-volatile EEPROM memory, use the button in tool bar.

Using the Alarm output pins as general purpose outputs (P175)

Storing a special value to the time duration alarm registers (I to L) the alarm output is overridden by user defined state. This special value can be either GD for logical low (0) or GH for logical high (1).

This feature can be used for switching of external circuits using up to four independent logical outputs. General purpose outputs can be controlled regardless of the operating mode.

J1 – Alarm output pin number	Command required	
	to force low (0)	to force high (1)
2	ARI:GD*X	ARI:GH*X
3	ARJ:GD*X	ARJ:GH*X
4	ARK:GD*X	ARK:GH*X
5	ARL:GD*X	ARL:GH*X

Notes:

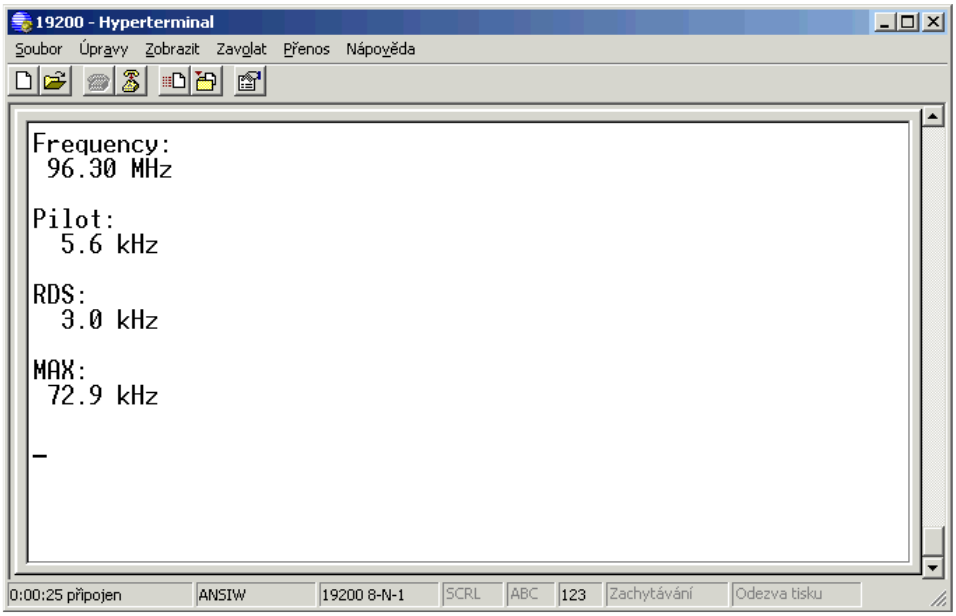
1. Pin 1 is located on the right.
2. It may take up to one second before the pin state is updated.
3. To control the pin state from the FM Scope script, use the command send, for example: send(ARI:GD*X)
4. To reactivate all alarms, place valid numerical values (00-99) into the time duration registers. Optionally store the setting to EEPROM and restart the unit.

Data format

The format of all data returned by the device is defined as follows:

key+":"+Chr(13)+Chr(10)+Chr(13)+Chr(10)
(if return value is empty)

key+":"+Chr(13)+Chr(10)+**value**+Chr(13)+Chr(10)+Chr(13)+Chr(10)
(otherwise)



Example of the outputs when using Windows HyperTerminal. Local echo is off.

List of keys

Key	Invoked by	Key	Invoked by
Frequency	?F	Pilot	?L
G	*R	RDS	?R
PS	?D	RDS Group Statistics	?T
PI	?D	MAX	?M or *M
RT	?D	AVE	?A
LTO	?D	MIN	?N
CT	?D	IF	?I
PTY	?D	ASCII	xxx,xxx?a
MS	?D	HEX	xxx,xxx?h
TP	?D	FV	?V
TA	?D	Signal Quality	?Q
AF	?D	Fast Signal Info	?G
DI	?D	Modulation Power	?P
EON	?D	Pm	*P
ECC	?D	RDS Phase Difference	?E
LIC	?D	Histogram Data	?H
PTYN	?D	FFT Data	?S
PIN	?D	MAX Hold	?X
R/L	?C	Level	?U

FM Scope for Windows

The FM Scope is a PC application primarily made for the P75/P175 automated control, data visualization and data archiving. The application is provided for free download on the website.

The FM Scope main screen.

Basic features

- Graphical, text and MS Excel data output
- Proprietary script language allows fully automated monitoring and data logging
- Built-in task scheduler, mp3 recorder, FTP upload, MySQL and SMTP email client
- TCP/IP remote control, built-in simple web server
- Free download – no additional costs

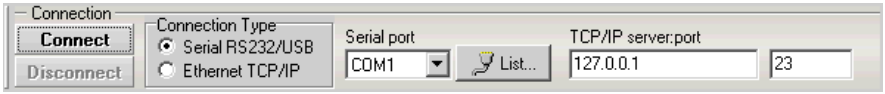
System requirements

- CPU: 200 MHz minimum, 700 MHz or better recommended
- Screen resolution: 800x600 minimum, 1280x1024 or higher recommended

First steps

1. In case of USB connection (or USB to RS-232 adapter) install the USB driver first.
   Pure RS-232 connection never requires any extra driver.
2. Install the FM Scope.
3. Connect the equipment.
4. Run the FM Scope.
5. Select the COM port where the FM analyzer is connected and click Connect.
   If you use USB connection, you may find the COM port number in the adapter's driver setup (usually in Windows Control panels).
6. Make sure the FM analyzer is powered.
7. Acquire a bandscan to get a list of stations or select a frequency and click Tune. The frequency tuned must be indicated in the Station bar.
8. Now you are ready.

Connection to the device

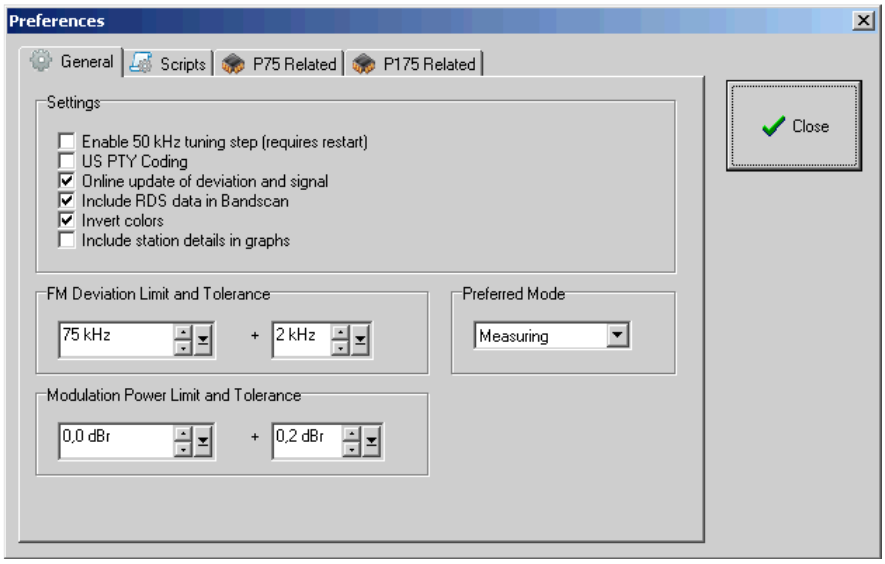


Connection Type – Select the first option if you use RS-232 or USB connection.

Serial RS232/USB:
Serial Port – The COM port to which the FM analyzer is connected.
Ethernet TCP/IP:
TCP/IP Server – Host name or IP address of the remote site where the FM analyzer is connected.
TCP/IP Port – Use the same port as on the remote site.
Any commercially available Ethernet-to-RS232 adapter can be used on the remote site.
Suitable software based Ethernet-to-RS232 converter is available for example at http://pira.cz/eng/piracom.htm – run this converter on the remote site PC.

Connect – Opens the connection.
Disconnect – Closes the connection.

Preferences



Enable 50 kHz tuning step – Check **only** if there are stations in your area broadcasting in 0.05 MHz raster.
US PTY Code – Check if your location belongs to US broadcasting area.
Online Update of Deviation and Signal – If checked, the deviation and signal values are updated continuously. Typically, this option must be enabled in order to see actual values!
Invert Colors – Enables "night mode", inverts all colors in the graphs and text windows.
Allow multiple instances – Allows launching more application instances at one time. Each application must be installed separately in a different sub-folder.
Common settings for all Windows users – Switches between common application settings for all Windows users or keeping separate settings for each user.

Include RDS data in Bandscan – Enables PI and PS showing in bandscan.
Always check for actual PS and PI – Enables reading actual RDS data (PS and PI) for the station although it is already known or was entered manually. Has no effect if previous option is disabled.

FM Deviation / Modulation Power Limit and Tolerance – Broadcast limits and additional measuring tolerances that are given by authority in your country. *The tolerance settings have no effect on the measurement precision.*

Preferred Mode – The mode selected will be used on connect.

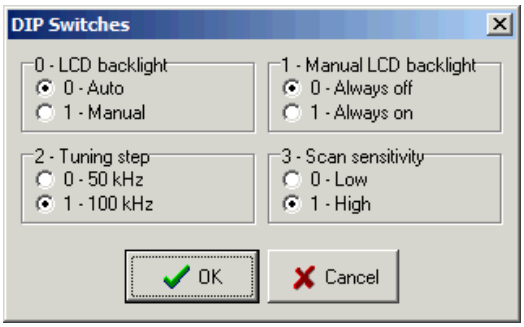
Debug mode – If checked, the script execution will stop on errors and error message will be displayed.

The application will remember these settings automatically. The settings are saved on application exit or can be saved manually using File – Save Settings Now.

DIP switches

The "DIP switches" nostalgic term represents a way how to configure some special settings of the device. These settings are not directly accessible on the device but can be controlled from the PC.

Select Options/DIP switches from the main menu.
To fix the changes do not forget to save them into EEPROM (button).

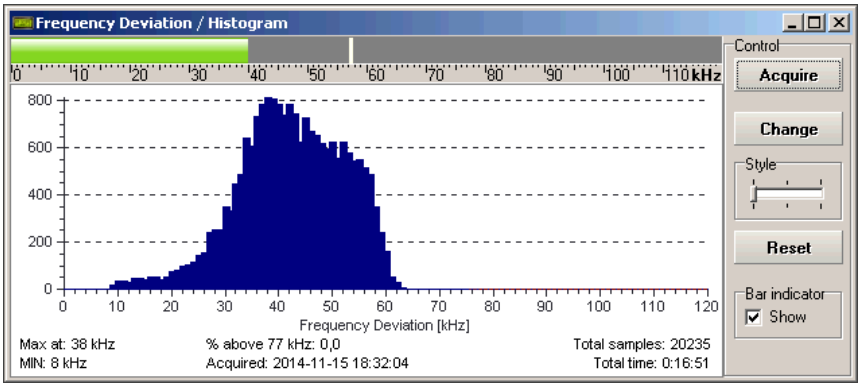


Currently it's possible to configure LCD backlight, tuning step, scan sensitivity and noise cancellation between stations (squelch and scan mute). Other options, if present, should be disabled.

Tool bar

- Save data from actual window, usually in *.csv text format readable by MS Excel etc.
- Save bitmap image of actual window
- Copy bitmap image from actual window to Windows clipboard
- Show Preferences dialogue box.
- Show Task Scheduler
- Station lists
- Cascade windows
- Tile windows horizontally
- Tile windows vertically
- Lock all windows – protect from unwanted resizing or movement
- Acquire all data from the device
- Save complete text report
- Store actual device settings to its internal EEPROM memory

Frequency deviation, histogram and accumulated distribution plot



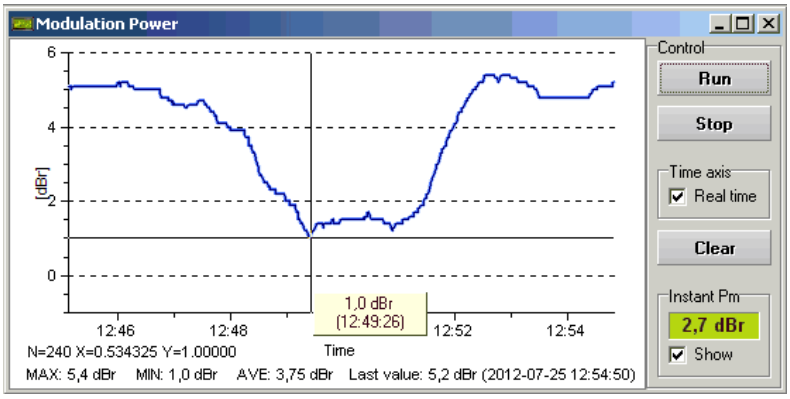
Acquire – Acquires the Frequency deviation data from the FM analyzer.
Change – Switches the display between histogram and accumulated distribution plot.
Reset – Clears all values. Equivalent to the Clear Data option in the FM analyzer's menu.
Show Bar Indicator – Shows fast peak deviation bar indicator with 1 sec. max hold function. The update rate is approx. once per 50 ms. Clicking on the scale, the unit can be switched between kHz and %. The 'Online update' option must be enabled in the Preferences. Requires firmware version 1.5 or later!

The frequency deviation histogram reflects the station's modulation characteristics captured over a time. It does not and it cannot provide instantaneous values, however using the histogram data the modulation is best described.

The frequency deviation histogram typically needs the station to be tuned at least a few minutes before clicking the Acquire button to provide relevant data.

Modulation power

The application can collect the Modulation power (also known as MPX power, P_m) data and show them as a function of time. Clicking in the graph the user may track the data.

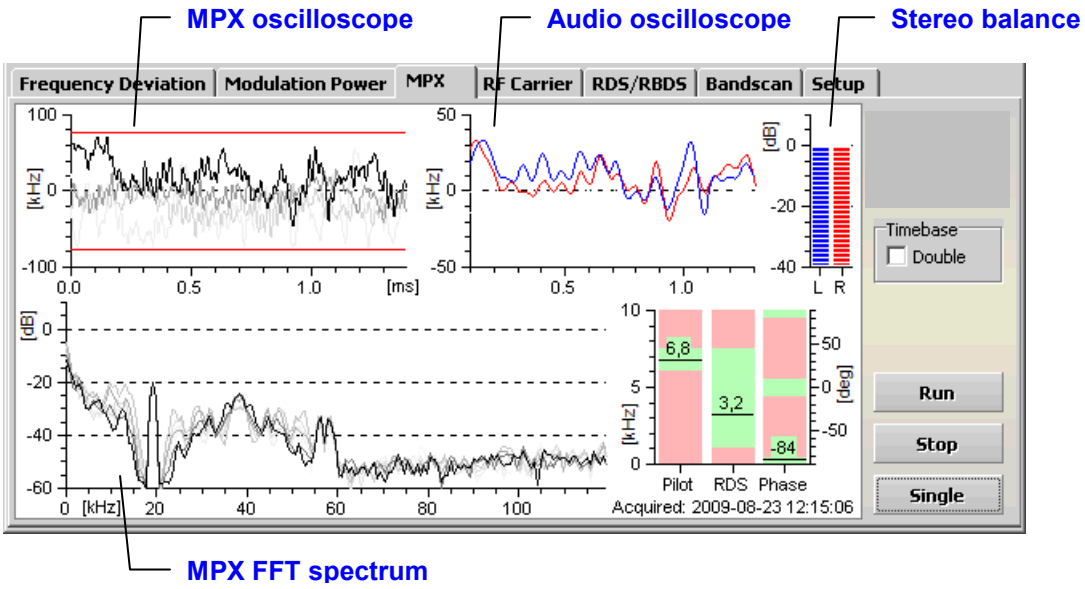


Run – Starts the measurement. Since Modulation Power is averaged over 60 seconds, first value will be available 1 minute after tuning the station.
Stop – Stops the measurement.
Time axis – Assigns real time or 0:00 to the first value in the data.
Include Deviation MAX – Adds deviation MAX curve.
Include Signal Quality – Adds signal quality (0 to 5) curve. Due to better readability the value is multiplied by two.
Clear – Clears the Modulation power data and graphic window.
Instant Modulation Power (P_m) – Shows the last one-second component of the modulation power, i.e. the modulation power averaged over one second. This value is useful especially for checking and adjusting modulation processor's algorithms and settings. It's available almost immediately after the station is tuned. Note that this value can't be compared with modulation power limit due to short averaging period.

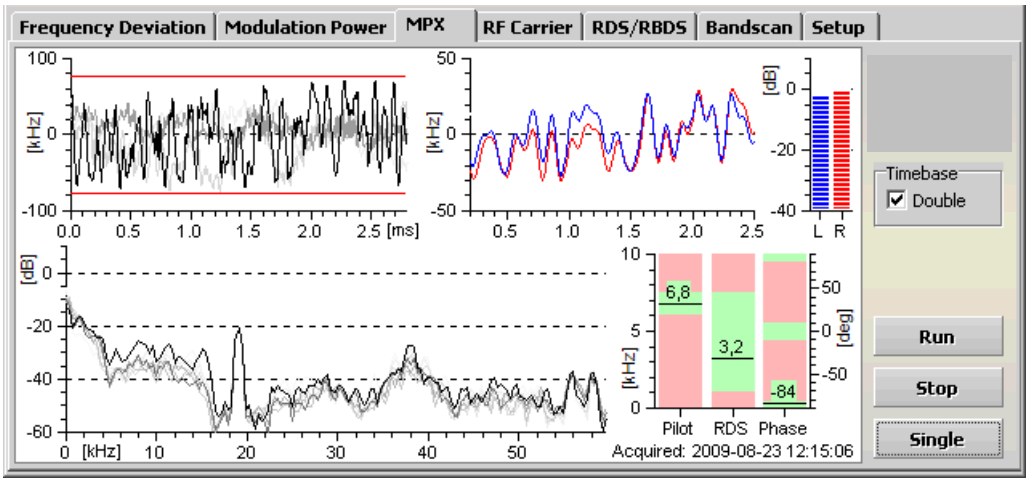
MPX

The MPX (multiplex) signal is the signal that goes into the modulation input of the FM transmitter. It typically consists of audio L+R, pilot tone 19 kHz, audio L-R modulated on 38 kHz (DSB-SC method) and additional components like RDS.

The MPX page includes MPX oscilloscope, audio oscilloscope for both channels, stereo balance meter, MPX spectrum and pilot and RDS levels and their phase relation. Average refresh rate is 3 times per second for the scope functions.



Run – Starts the measurement.
Stop – Stops the measurement.
Single – Gets the data in only one process.
Clear– Clears the data and graphic window.

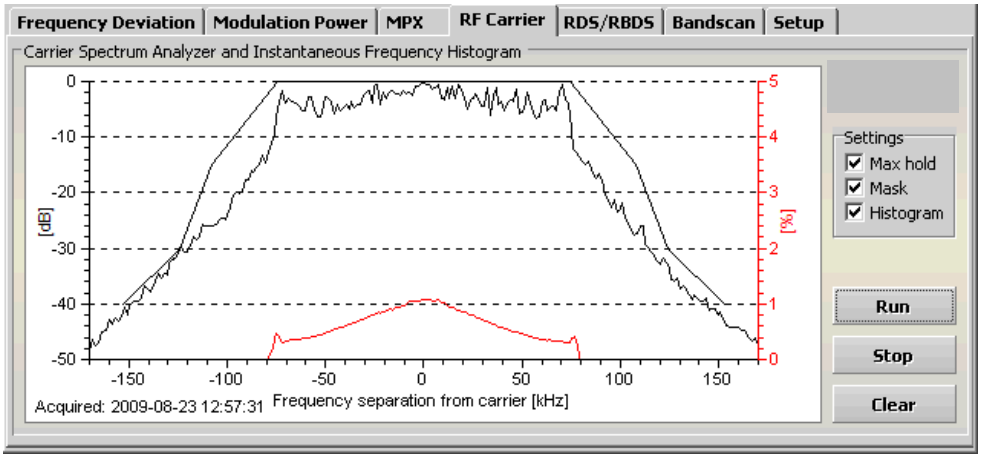


The Double timebase effect on X axes.

Note to FFT module: 0 dB ref. to 75 kHz frequency deviation for sine modulation signal.

RF Carrier

The RF Carrier page provides an access to the RF carrier spectrum and histogram of its instantaneous frequency.



Run/Stop – Starts/Stops the measurement.
Clear – Clears the data and graphic window.
Mask – Shows the spectral mask as defined by REC 54-01 E.

Note: 0 dB ref. to full level of unmodulated RF carrier.
Note: To show the carrier spectrum, the Double timebase from the MPX page must be disabled (unchecked).

Spectrum mask based method and its limitations

This method was used in past as a verification to indicate whether the frequency deviation of an FM broadcasting station exceeds the limits. The method has mainly historical reason and was originally designed for analogue spectrum analyzers. Implementation in the FM Scope is based on Fast Fourier Transform (FFT) rather than sweeping over the band, thus the result may not be directly comparable between these devices.

The mask method is a simple "go – no go" test based on a spectrum mask which **cannot** replace precise measurements of the peak frequency deviation that was described on previous pages. The essence of the method is to determine whether the spectrum plot (in max hold mode) is within the limits of the mask. Record the transmitter signal over a period of minimally 10 minutes (the more the better). The user must ensure that no measurement results are evaluated which have been distorted by impulse interference. For the same reason the measurement should be repeated twice.

The main disadvantage of the mask based method and especially its FFT implementation is that it may give positive result although the peak deviation is above 75 kHz. In other words, the transmission device may pass the mask based method test but this does not mean that the peak deviation is really within the limit.

The reason is that spectrum is always associated with energy averaged over some time. This time is considerably longer than modulation peaks that may occur. Single strong peak in the signal may still carry less energy than a series of weak peaks. This basic fact determines that spectrum based method cannot be reliably used for finding peak deviation. It is an approximation method. Stations with a small number of peaks above 75 kHz can pass the mask based method. Applied to reality, stations that do not use strong audio compression and clipping can pass the mask based method although the peak frequency deviation is above the limit. It must be also noted that real peak deviation measurement covers 100 % of the time and suppresses interference impact while the spectrum based method doesn't.

Conclusions:

- The benefit of the mask based method is that compares real spectrum occupation caused by the station.
- If the spectrum plot is outside the mask on any frequency, the transmission device may be considered as overmodulating. If the spectrum plot is within the mask, additional peak frequency deviation measurement must be always made to verify if the station exceeds the peak deviation limit or not.

Advanced use of the RF carrier spectrum analysis

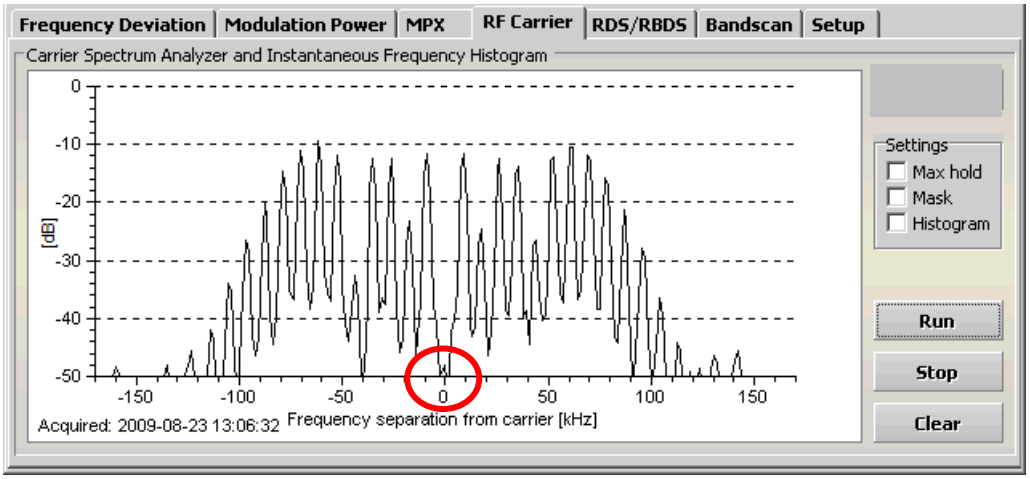
The RF carrier spectrum analysis is a very useful tool for very accurate measuring of FM deviation and modulation index and for making fast and accurate adjustments of FM transmitters on selected single modulation frequency (sine tone). The transmitter is adjusted to a precise frequency deviation with the aid of the spectrum analysis using the effect called "carrier zero" and selecting the appropriate modulating frequency f_m and modulation index β. This method requires a sine signal generator connected to the FM transmitter modulation input.

Modulation index is expressed as:

$$\beta = \Delta F / f_m$$

Following table gives the lowest order modulation indexes that result in carrier zero in the spectrum:

Order of carrier zero	1	2	3	4	5	6	n (n>6)
Modulation index β	2.40	5.52	8.65	11.79	14.93	18.07	18.07+π(n-6)



In the figure above, a modulation frequency of 8.67 kHz and a modulation index of 8.65 (third carrier null) necessitate a carrier peak frequency deviation of 75 kHz.

Since we can accurately set the modulation frequency on a signal generator and since the modulation index is also known accurately, the frequency deviation thus transmitted will be equally accurate (typically better than ±0.3 kHz).

Recommended procedure for setting up a known deviation:

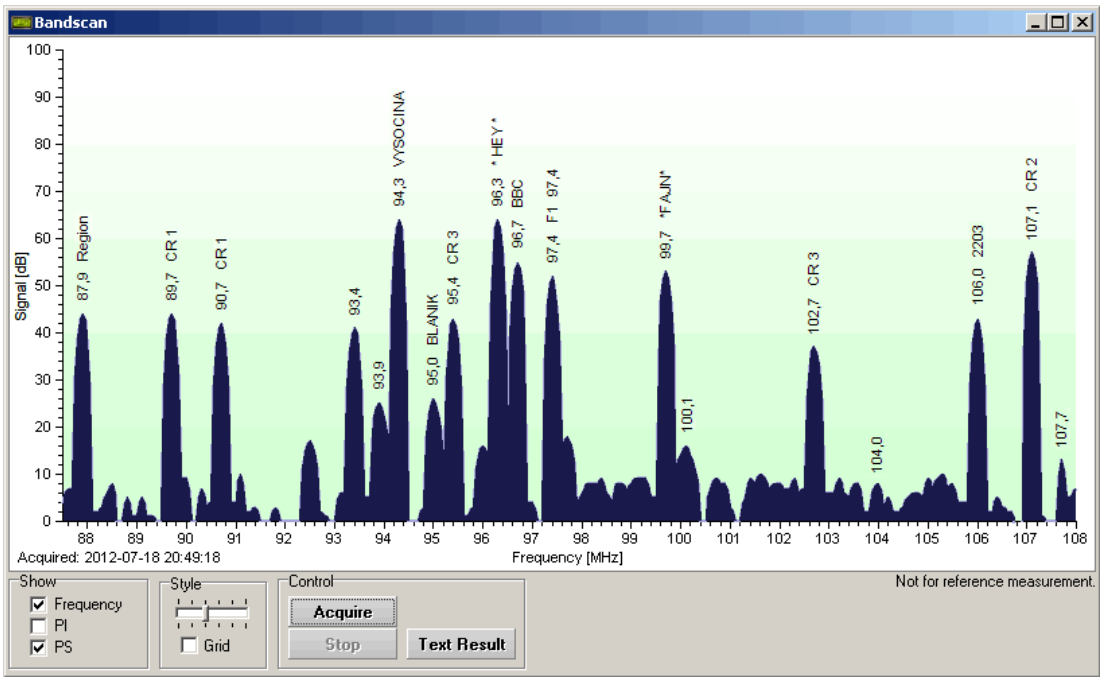
1. Select the required deviation ΔF.
2. Select a modulation index β that gives a modulating frequency commensurate with the normal modulation bandwidth of the transmitter to be tested.
3. Set the modulating frequency to ΔF / β, and monitor the output spectrum of the FM transmitter on the RF Carrier page. Step up the amplitude of the modulating signal from zero level and stop when the carrier is at the desired order of zero.

Note: Pilot tone and RDS must be switched off on the transmission equipment before making this measurement.

Bandscan

This is an additional feature which shows quick graphic representation of the band occupation and estimated signal strength. By clicking on a station peak you may directly tune the station. The strongest stations are copied into actual station list and showed in the Station bar, allowing quick tuning.

Due to physical characteristics of the device, this feature is not intended for coverage analysis nor reference signal strength measurement! The bandscan effectively shows a visualized list of stations detected rather than showing a simple print of amplitude spectrum. The station's detection ability is among others affected by the RF signal bandwidth which is fixed at 280 kHz, as required for proper measurement of modulation characteristics.



Acquire – Acquires the Bandscan. The scanning is indicated in the application bottom line.
Stop – Aborts the operation.
Text Result – Copies the station list in the Text window.

Style – Selects from various displaying styles.

If RDS data is enabled for bandscan in Preferences, the bandscan may show PI and PS for each station. However it may take a few minutes before the bandscan finishes due to additional time required for getting RDS data.

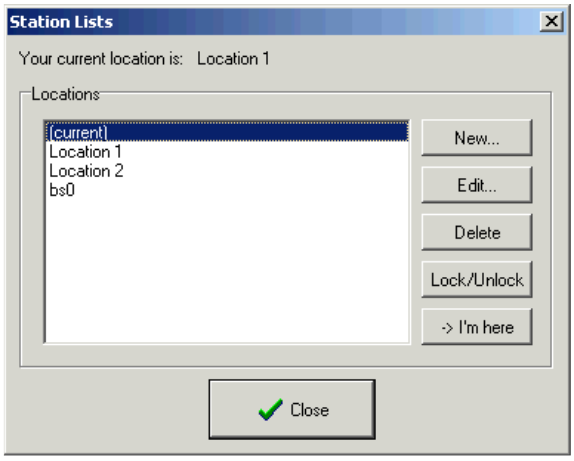
Note (P75): 0 dB ref. to approx. 0.5 µV on the antenna input. Max. dynamic range is <80 dB. The signal value on the Y-axis is estimated from the Signal and Noise Level values from LCD page 5. Precision is not specified for this function.

Note: The bandscan supports 100 kHz tuning step only.

Station lists

The idea of Station lists is to store and switch between different bandscans and station presets. This is especially useful if one makes monitoring in different locations as it can quickly tune the stations of interest. A separate station list can also be a source for some automation scripts without affecting station presets dedicated for manual control.

To access the Station lists, click on the button .



New… – Create new location (station list). Up to 15 locations can be created.
Edit… – Edit the location. Allows to edit, add and delete stations from the list.
Delete – Delete the location selected.
Lock/Unlock – Affects how the Bandscan feature processes current list. Stations from locked list are merged with stations from new bandscan. Stations from unlocked list may disappear if they are not recognized in new bandscan. However stations that were entered or edited manually will never disappear from the list, regardless of the lock/unlock state.
-> I'm here – Load the location selected.

To fill the list with station presets, take a bandscan or click on the Edit button.

To tune the station, select it in the Station toolbar and click on Tune.

To show complete station list data, click on the Text output button in Bandscan window.

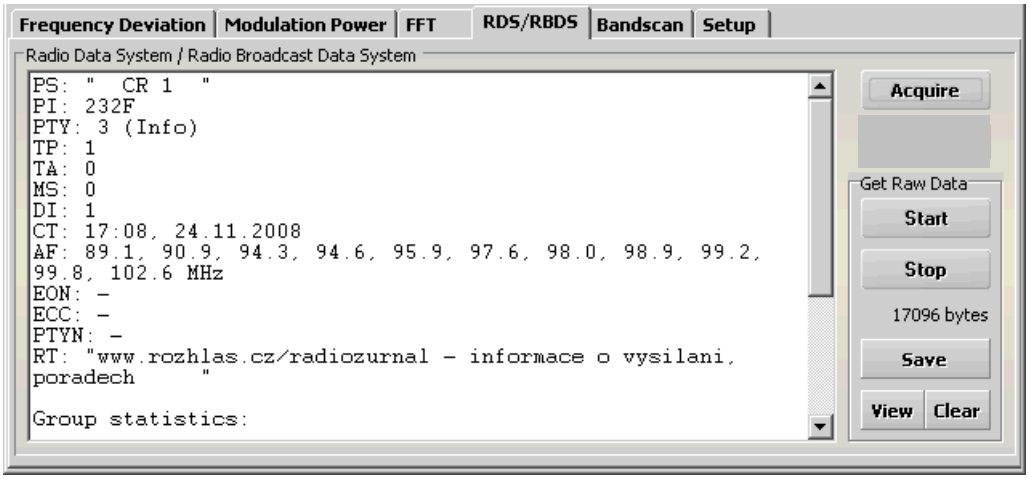
Text window

The Text window primarily provides one of the text output possibilities for automation scripts.

The Text window also serves as a console, i.e. it allows entering script commands in the bottom line. For example if you type exit confirmed by <Enter>, the application terminates. If you type %time, the window shows content of the variable named time – actual time. To use the console, there must be no other script running.

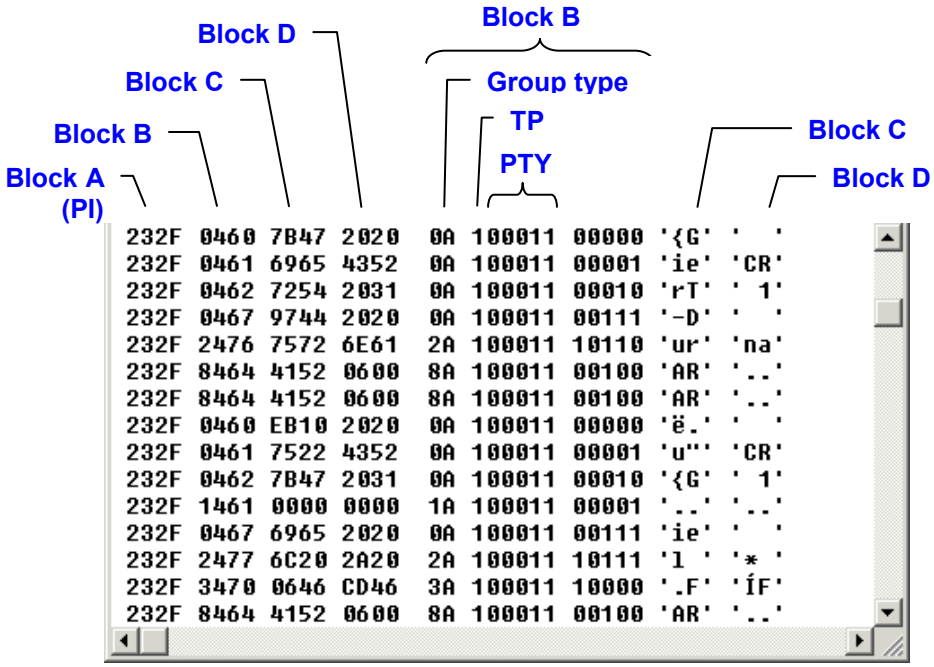
The script language is described later in this manual.

Radio Data System / Radio Broadcast Data System



Acquire – Acquires the RDS data. To see actual data, the Mode must be set to RDS.
In addition, error or warning messages are included in the report if any problem is found in the RDS settings.

Get Raw Data – Captures raw RDS data in real-time and allows saving them to a text file in following format:



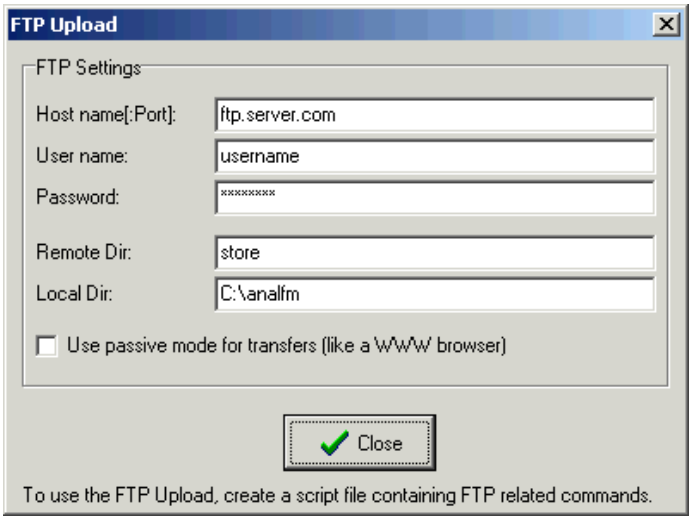
Maximum capture buffer length is 128 kB. Each RDS group consists of 8 bytes (4 blocks of 2 bytes each).
The file is readable in any text viewer and provides full possibility of RDS stream analysis. All content is showed in hexadecimal representation and where applicable, additional decimal, binary or ASCII representation is used. The file starts with older RDS groups and ends with last RDS group.

Note: For complex real-time RDS analysis, please download the RDS Spy software: ***http://rdsspy.com***

FTP upload

File Transfer Protocol (FTP) is a network protocol used to transfer data from one computer to another through a network such as the Internet. This operation can be fully automated through the script files.

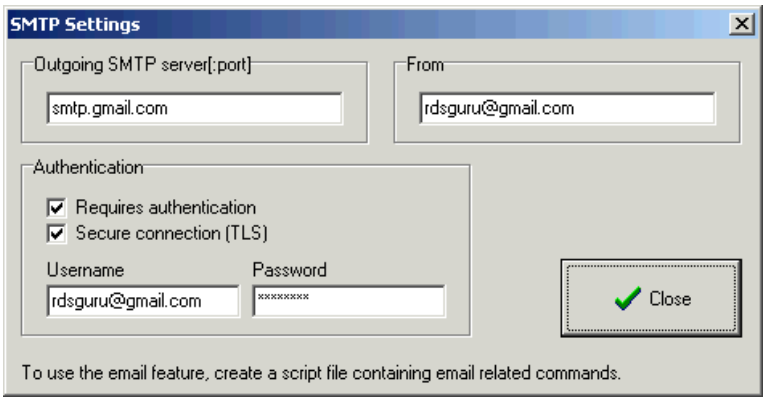
The FTP Upload feature needs to be set before first use. In main menu, choose Options/FTP Upload.



To use the FTP upload, create a script file containing FTP related commands (see the list of commands and the examples). This feature can be also combined with Task scheduler to create fully automated online system of monitoring with www based output.

SMTP Email client

The application includes simple SMTP client that allows sending emails to one or more recipients with optional file(s) attached. The email client is controlled via script. Setting up the SMTP parameters is necessary before use. In main menu, choose Options/SMTP Settings.

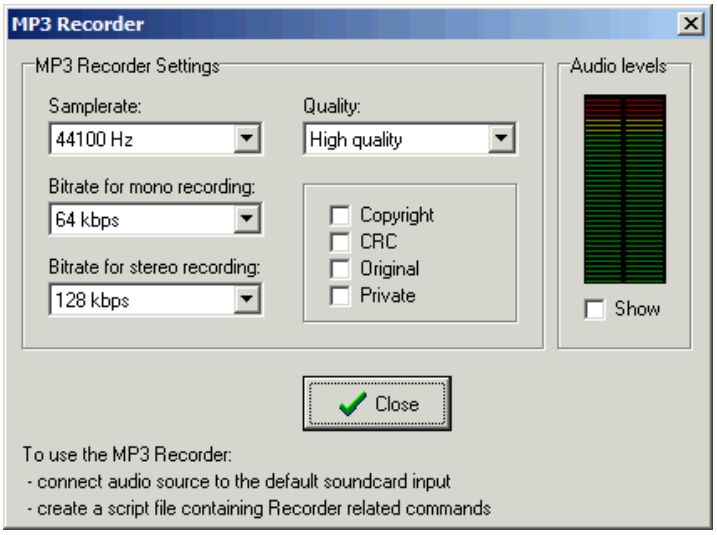


Information about how to set up the SMTP parameters is available from your mail account support or internet connection provider (ISP). The 'From' field must also be specified, it is usually the email address associated with your email account.

If your ISP blocks default SMTP port 25, use port 587 instead, for example smtp.gmail.com:587

MP3 recorder

The MP3 Recorder feature needs to be set before first use. In main menu, choose Options/MP3 Recorder.



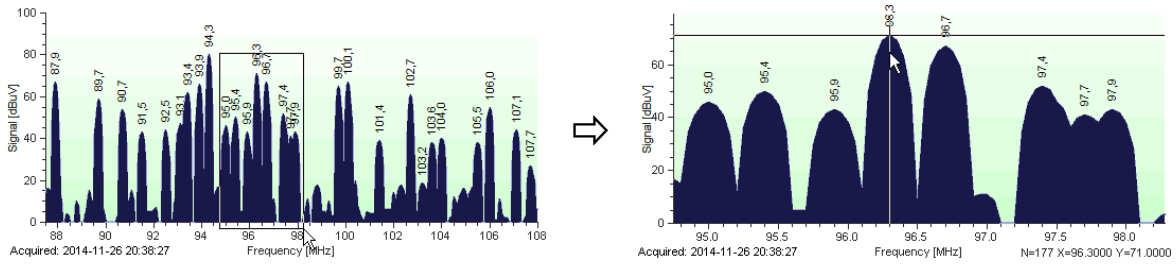
To use the MP3 recorder, connect the audio source to the default soundcard input using any metalic audio cable. Create a script file containing MP3 recorder related commands (see the list of commands in section Script Files / List of commands / Working with files). This feature can be also combined with Task scheduler to create fully automated system of recording.

Make sure the file lame_enc.dll is placed in the application folder. This file is a part of the installation package or may be downloaded from the net.

Important! Recording audio content may violate copyright laws!

Zoom option

Any graph window can be maximized over the entire workspace. Above that you can zoom in on your graph with the zoom function, or in other words enlarge a certain part of the graph. The zoom option uses mouse and can be applied to all graphs in the application if no graph is being refreshed by new data.



Press the CTRL key and keep it pressed, click the mouse in the graph area and pull a rectangle. To unzoom the graph simply press the CTRL key and click with the mouse on the graph without moving it.

Script files

The application supports proprietary script language which massively extends the area of use and number of features. User can fully automate the measurements and data storage. The script files can contain only a few steps as well as large blocks of data acquisition and processing procedures. Presence of that feature and its possibilities may be compared with top systems from this branch.

The script files extension is .fms. To run the script, choose corresponding option in the application's menu or use command line option, for example:

```
fmscope.exe measure.fms
```

Each line in the script file may contain one command. The command interpreter is not case-sensitive. Maximum line length is 1024 characters, maximum script total length is 2048 lines.

Quick access

User can quickly run the script by selecting its name in the Script submenu. That script file must be saved in the application's subfolder named 'usr'.

List of commands

Command	Meaning	Example of use
General purpose and application control:		
connect	Open a COM port (given by number) or TCP connection (given by host:port) for communicating with the device. If TCP connection fails for any reason, automatic reconnection attempts follow with 20 sec. period. If no argument is specified, last connection parameters are used. If a connection is already established, nothing happens.	connect(1) connect(localhost:23) connect(127.0.0.1:23) connect
disconnect	Close the connection. If no connection is opened, nothing happens.	disconnect
send	Send any string to serial port.	send(?F) send(*B) send(?C)
setproperty	Set an application property to a new value. Compete list of properties is given in Annexes.	readproperty(TempValue,InvertColors) setproperty(InvertColors,0) ... your script here ... setproperty(InvertColor,%TempValue)
readproperty	Read an application property and place its value to a variable.	
page.show	Switch the FM Scope display to the page (window) specified as parameter (0 to 6).	page.show(2)
showmessage	Show a dialogue window with user defined message. Useful for debug purposes.	set(variable1) showmessage(Variable value: %variable1)

Measurements:

location.load	Select and load the location (station list) by its name. If no location of that name is found, it is created automatically.	location.load(MyLocation1)
location.lock	Lock current location (merge mode for bandscans).	location.lock
location.unlock	Unlock current location.	location.unlock
tune	Tune to a frequency specified in MHz.	tune(89.6)
setmode	Set the operating mode to Measuring (0) or RDS (1).	setmode(0)
getpilot	Get pilot deviation value.	getpilot
getrds	Get RDS deviation value.	getrds
getquality	Get signal quality value.	getquality
getamod	Get current AM value in % (P175).	getamod
getlevel	Get current signal level (P175).	getlevel textwindow.addline(Level is %level)
getnoise	Get current noise	getnoise
getphase	Get pilot-to-RDS phase difference value.	getphase
frequencydeviation.acquire	Acquire actual frequency deviation data (incl. histogram).	frequencydeviation.acquire
frequencydeviation.histogram	Switch the display between histogram (1) and accumulated distribution plot (0).	frequencydeviation.histogram(1)
frequencydeviation.showbar	Enable (1) or disable (0) showing of the instantaneous frequency deviation bar.	frequencydeviation.showbar(0)
modulationpower.run	Run the modulation power measurement.	modulationpower.run
modulationpower.stop	Stop the modulation power measurement.	modulationpower.stop
modulationpower.clear	Clear the modulation power data.	modulationpower.clear
modulationpower.realtime	Enable (1) or disable (0) showing of real time / deviation MAX / signal quality in the modulation power graph.	modulationpower.realtime(1)
modulationpower.includedeviation		modulationpower.includedeviation(1)
modulationpower.includesignal		modulationpower.includesignal(1)
mpx.single	Get actual MPX and RF data.	mpx.single
mpx.run	Run the MPX and RF Carrier related measurement.	mpx.run
mpx.stop	Stop the MPX and RF Carrier related measurement.	mpx.stop

mpx.clear	Clear the MPX data.	mpx.clear
mpx.doubletimebase	Set normal (0) or double (1) timebase.	mpx.doubletimebase(0)
rf.run	Equal to mpx.run	rf.run
rf.stop	Equal to mpx.stop	rf.stop
rf.clear	Clear the RF data.	rf.clear
rf.maxhold	RF spectrum max hold mode.	rf.maxhold(1)
rf.mask	Spectral mask display.	rf.mask(1)
rf.histogram	Instantaneous RF carrier histogram display.	rf.histogram(1)
rds.getdata	Get RDS data.	getrdsdata
rds.getstatistics	Get RDS group statistics.	getrdsstatistics
rawdata.start	Start to capture raw RDS data.	rawdata.start
rawdata.stop	Stop capturing RDS data.	rawdata.stop
rawdata.clear	Clear the raw RDS data buffer.	rawdata.clear
bandscan.acquire	Acquire actual bandscan.	bandscan.acquire
bandscan.style	Select the bandscan style. Value 0 (zero) corresponds with the first option.	bandscan.style(3)
bandscan.grid	Enable (1) or disable (0) the bandscan grid.	bandscan.grid(0)
bandscan.showfrequency	Enable (1) or disable (0) the frequency indication above the station's peak.	bandscan.showfrequency(1)
bandscan.showpi	Enable (1) or disable (0) the RDS PI indication.	bandscan.showpi(0)
bandscan.showps	Enable (1) or disable (0) the RDS PS indication.	bandscan.showps(1)
imf.setasnormal	Set actual 2nd IF frequency as a normal. Allows to measure carrier offsets and to show this value in Report.	imf.setasnormal
imf.get	Get actual 2nd IF frequency.	imf.get

Windows clipboard:

frequencydeviation.copybitmap	Copy the frequency deviation bitmap to clipboard.	frequencydeviation.copybitmap
modulationpower.copybitmap	Copy the modulation power bitmap to clipboard.	modulationpower.copybitmap
mpx.copybitmap	Copy the MPX bitmap to clipboard.	mpx.copybitmap
rf.copybitmap	Copy the RF bitmap.	rf.copybitmap
bandscan.copybitmap	Copy the bandscan bitmap to clipboard.	bandscan.copybitmap

Working with files:

savetext	Save a text to a file (overwrite).	savetext(%date.txt,OK)
appendtext	Save a text to a file (append).	appendtext(%date.log,%crPilot: %pilot)
frequencydeviation.savedata	Save the frequency deviation data.	frequencydeviation.savedata(histogram.txt)
frequencydeviation.savebitmap	Save the frequency deviation bitmap.	frequencydeviation.savebitmap(%date.bmp)
modulationpower.savebitmap	Save the modulation power bitmap.	modulationpower.savebitmap(pm.bmp)
modulationpower.savedata	Save the modulation power data.	modulationpower.savedata(pm.txt)
mpx.savedata	Save the FFT data.	mpx.savedata(fft.txt)
mpx.savebitmap	Save the MPX bitmap.	mpx.savebitmap(mpx.jpg)
rf.savebitmap	Save the RF bitmap.	rf.savebitmap(rf.jpg)
bandscan.savebitmap	Save the bandscan bitmap.	bandscan.savebitmap(%date.bmp)
rds.savedata	Save the RDS data (incl. group statistics)	rds.savedata(rds data %rdsps.txt)
rawdata.save	Save the raw RDS data.	rawdata.save(rds raw data.txt)
textwindow.savedata	Save actual content of the text window to a file.	textwindow.savedata(c:\text.txt)
createreport	Create and save the report.	createreport(report %freq.txt)
recorder.run	Run the MP3 recording to the file and from the channel(s) specified. The channel(s) may be left, right, mono or stereo.	recorder.run(c:\rec.mp3,mono)
recorder.stop	Stop the MP3 recorder.	recorder.stop
checkfilename	Remove invalid filename characters from second argument, store result to the variable in first argument.	checkfilename(fn,%freq %rdsps) savetext(C:\%fn.txt,%rdspi%cr%rdsps)
savesettings	Save the application settings now.	savesettings

MySQL client:

mysql.connect	Connect to the MySQL server specified in MySQL Client settings.	mysql.connect
mysql.query	Sends a database query using the SQL syntax. *Does not allow to retrieve data from the database.*	mysql.query(CREATE TABLE table1 (column1 FLOAT)) mysql.query(INSERT INTO table1 VALUES (%maxhold_))
mysql.disconnect	Disconnect from the MySQL server.	mysql.disconnect

Sending email:

email.to	Recipient's address(es).	email.to(info@radio.com, luis@radio.com)
email.subject	Message subject	email.subject(FM Scope Message)
email.body	Message body	email.body(Silence detected on %frequency!)
email.attachfile	Attach the file specified. To attach more files, use this command repeatedly. After the email is sent, the attachment's queue is cleared.	email.attachfile(C:\monitor\histogram.jpg)
email.send	Send the email. Don't forget to configure the SMTP settings in Options submenu prior to send any emails!	email.send

Script flow control:

execute	Execute any application, open any document or run another script. Optional command line parameter(s) may be specified. If no path is specified, default path is %appfolder\. Does **not** wait until the application terminates!	execute(C:\batch.bat) execute(notepad.exe,text.txt) execute(command,/c md c:\data) sleep(2) execute(usr\another_script.fms)
sleep	Stop executing next commands for a time specified in seconds.	sleep(30)
include	Include another script file (replacing the include command) into this script file **before** processing the script.	include(savedata.fms)
goto	Go to another line of the script. The line is identified by a unique label followed by pit-pair. In the goto argument the pit-pair is omitted.	repeat: ... goto(repeat)
call	Call subroutine. The first line of the subroutine is identified by a unique label followed by pit-pair. In the call argument the pit-pair is omitted. Nesting of multiple subroutines calls is allowed.	call(myproc) ... stop myproc: ...
return	Return from subroutine. Continue on next command after last call.	return
exit	Exit the FM Scope.	exit

if	Allows for conditional execution of script fragments.
	Only one condition is allowed per one if command.
	
	Only these operators are allowed:
	> greater than,
	< lower than,
	>= greater than or equal to,
	<= lower than or equal to,
	= equal to (numeric comparison),
	!= not equal to (numeric cmp.),
	$= equal to (string cmp.),
	@ included in (string cmp.).
	
	Operators like *and*, *or*, *not* are not permitted, however nesting of multiple if commands is possible.
	
	If the variable does not contain valid numeric value, its numeric value is considered as -1 for the purpose of numeric comparisons.
		If (%connected=0)
		  showmessage(Not connected!)
		  stop
		  endif
		
		getquality
		if (%quality>3)
		  call(myproc)
		  endif
		
		getfrequency
		if (%freq@09630 10600 10710)
		  return
		  endif

stop	Don't execute next commands in the script file. Stop processing the script.	stop

Text window output:

textwindow.addline	Add a new line to the bottom of the text window.	textwindow.addline(This is a new line)
textwindow.rewriteline	Rewrite the last line in the text window.	textwindow.rewriteline(New text at %time)
textwindow.addtext	Add a text to the end of the last line.	textwindow.addtext(Line now ends here.)
textwindow.clear	Clear entire content of the text window.	textwindow.clear

Working with FTP:

ftpconnect	Connect to the FTP server specified in FTP Upload settings.	ftpconnect
ftpput	Put the file on the server. Optionally the filename on the server may differ from the local filename.	ftpput(%date.log) ftpput(%freq.jpg,histogram.jpg) ftpput(%date.log,results/log.txt)
ftpdisconnect	Disconnect from the FTP server.	ftpdisconnect

Working with HTTP:

httpget	Access the URL specified, optionally pass parameter(s) using GET method. The accessed site's content is not stored anywhere.	httpget(http://site.com/log.php?s=%freq)

Working with variables:

set	Initiate a variable (general type) and assigns a value to the variable. If no value is specified, a value of 0 is assigned.
	Any variable that is not set first has permanently a value of -1.
	When need the variable value, a prefix % must be added.
	The variables remain in the application memory until its exit or applying reset command.
		set(variable1)
		set(msg,Counting...)
		repeat:
		showmessage(%msg %variable1)
		inc(variable1)
		if (%variable1<5)
		goto(repeat)
		endif

inc	If there's a number stored in the variable, increase the variable by specified value. This value may be negative or floating point as well. If no value is specified, the variable is increased by 1.	set(starttime,%date %time) ... showmessage(Running since %starttime)

input	Permit the user to enter a text (or number).
	If any text is entered, a variable inputvalid is set to 1 and variable inputtext contains the text.
		input(Enter your location name)
		if (%inputvalid=1)
		checkfilename(fn,%inputtext)
		bandscan.savebitmap(%fn %time.jpg)
		endif

savedialog	Show standard save file dialogue box. Optional filter may be specified.
	If a file name is confirmed, a variable inputvalid is set to 1 and variable inputtext contains the file name (incl. path).
		savedialog(*.jpg)
		if (%inputvalid=1)
		bandscan.savebitmap(%inputtext)
		endif

opendialog	Show standard open file dialogue box. Optional filter may be specified.
	If a file name is confirmed, a variable inputvalid is set to 1 and variable inputtext contains the file name (incl. path).
		opendialog
		if (%inputvalid=1)
		execute(%inputtext)
		endif

save	Save content of specified variable to disk. Variable saved this way is available to all scripts using command load.	save(counter)
load	Load content of specified variable from disk. If no variable of that name has been saved before, a default value behind the comma is assigned.	load(counter,0) load(counter,%counter)
loadexternal	Like the load command but loads the content of variable from external file specified. The external file format is as follows: *[Global]* *variable1=value1* *variable2=value2* etc.	loadexternal(d:\control.txt,counter,0)
reset	Remove all variables from RAM. It is preferred to call this command on the beginning of your script whenever you don't need to keep variables created by previous scripts.	reset

Socket control:

get	Redirects the string to the socket control client. If terminal echo is enabled, the string is followed by CR+LF.	get(L: %lmaxdb, R: %rmaxdb) get(%pilot)
+++	Breaks any running script. The socket control related command. Must be also validated by <Enter>.	+++

Following tags may be used to create dynamic content, to get system values or to insert special characters:

Tag	**Meaning**
%time	Actual time in format HH-NN-SS
%date	Actual date in format YYYY-MM-DD
%timestamp	Number of seconds that have passed since 1.1.2000
%frequency	Frequency in long format (87.5 MHz)
%freq	Frequency in compact format (08750)
%offset	Carrier offset (if previously got by imf.get)
%offsetnoref	Carrier offset (if previously got by imf.get) without mention the reference frequency
%pilot	Pilot deviation
%rds	RDS deviation
%phase	Pilot-to-RDS phase difference
%quality	Signal quality (if previously got by getquality)
%amod	AM modulation in % (if previously got by getamod, P175 only)
%level	Signal level in dBµV (if previously got by getlevel, P175 only)
%noise	Noise as showed on LCD (if previously got by getnoise)
%abovelimit	% above dev. limit (histogram function)
%devtotallimit	Deviation limit incl. tolerance (as set in Preferences)
%maxat	MAX at (histogram function)
%totalsamples	Total number of samples (histogram function)
%min	Deviation MIN Hold
%devave	Deviation AVE
%maxhold	Deviation MAX (the value updated every second)
%tsmaxhold	10 sec. MAX (if previously got by send(?X))
%pmlast	Modulation power – last value
%pmmax	Modulation power – MAX value
%pmmin	Modulation power – MIN value
%pmave	Modulation power – AVE value
%pmabovelimit	% of time the modulation power is above limit
%pmtotallimit	Modulation power limit incl. tolerance (as set in Preferences)
%lmaxdb	Max. dB peak in left channel (MPX window)
%rmaxdb	Max. dB peak in right channel (MPX window)
%balance	Linear channel balance R/L (if previously got by *B followed by ?C)
%cr	CR+LF (end of line)
%tab	Tabulator
%rdspi	RDS PI

%rdsps	RDS PS
%rdsrt	RDS RT
%rdspty	RDS PTY
%rdsms	RDS M/S
%rdstp	RDS TP
%rdsta	RDS TA
%rdsdi	RDS DI
%rdsaf	RDS AF
%rdseon	RDS EON
%rdsecc	RDS ECC
%rdsptyn	RDS PTYN
%rdsstat1	RDS Group statistics 0A to 7A
%rdsstat2	RDS Group statistics 8A to 15A
%rdsstat3	RDS Group statistics 0B to 7B
%rdsstat4	RDS Group statistics 8B to 15B
%rdserr	RDS Settings Errors and Warnings
%connected	Returns 1 if communication port is opened or TCP connection is alive, otherwise returns 0.
%percent	Inserts % sign without processing subsequent expression as variable.
%location	Current location name
%stationcount	Total number of stations detected in bandscan
%stationindex	Points to station of interest from all stations detected in bandscan. Can be 1 to %stationcount.
%station.frequency	Frequency of the station pointed by the %stationindex - long format (87.5 MHz)
%station.freq	Frequency of the station pointed by the %stationindex - compact format (08750) suitable for use in file names
%station.level	Reception level of the station pointed by the %stationindex
%station.noise	Reception noise of the station pointed by the %stationindex
%station.rdspi	RDS PI of the station pointed by the %stationindex
%station.rdsps	RDS PS or description of the station pointed by the %stationindex
%station.userdata	Optional user data of the station pointed by the %stationindex
%inputtext	The text entered using input query or dialogue box
%inputvalid	Contains 1 if any text was entered using the input query or dialogue box, otherwise contains 0.
%tempfolder	A Windows folder where temporary files may be placed
%appfolder	FM Scope application folder, without trailing delimiter (\)
%lasterror	Contains a text of the last script execution error. User writable.
%tcpconfailed	Returns 1 if a TCP connection issue or manual disconnect has occurred during processing of the script. User writable – if used in the script, it must be set to 0 before communicating with the device. After the communication ends, the %tcpconfailed variable can be tested by if command. Measurement results should be discarded if the value of 1 is detected.

Important!
The tags above are reserved and are processed preferentially. This means that no variable name may start with any of these reserved tags, otherwise it may yield unexpected results.

To avoid showing of unit, place _ behind the tag, for example %maxhold will show `75.0 kHz` but %maxhold_ will show `75.0` only.

Note:
The script language is highly optimized for use with the P75/P175 FM analyzer equipment. The script engine however maintains simplicity, for example it does not support mathematical operations on the values measured.

Script file example 1

(Measure a station, save basic report.)

```
setmode(0)
tune(100.5)
sleep(600)
frequencydeviation.acquire
getpilot
getrds
getphase
createreport(c:\reports\%date %time – %frequency.txt)
```

Script file example 2

(Measure a station, save some values to a log file every minute in an infinite loop.)

```
setmode(0)
tune(91.9)
savetext(log.txt,%frequency log file starting at %date %time%cr)
repeat:
sleep(60)
getpilot
getrds
appendtext(log.txt,<%date %time> Pilot deviation: %pilot, RDS deviation: %rds%cr)
goto(repeat)
```

Script file example 3

(Periodically tune to stations of interest, append some RDS information to text files, each station one file)

```
setmode(1)
repeat:
tune(91.9)
call(savedata)
tune(95.8)
call(savedata)
tune(104.2)
call(savedata)
goto(repeat)

savedata:
sleep(180)
rds.getdata
appendtext(%freq.txt,%date %time%cr)
appendtext(%freq.txt,PS: %rdsps, PTY: %rdspty, TA: %rdsta,%crRT: %rdsrt%cr%cr)
return
```

Script file example 4

(Tune to a station, get RDS data and save them.)

```
setmode(1)
tune(91.9)
sleep(60)
rds.getdata
rds.getstatistics
rds.savedata(rds %freq – %rdsps.txt)
```

Script file example 5

(Get the carrier offset in the Report.)

```
tune(87.9)              ;this will be the reference station
sleep(3)
imf.setasnormal

tune(107.1)
sleep(3)
imf.get

createreport(C:\report – 10710.txt)

tune(104.3)
sleep(3)
imf.get

createreport(C:\report – 10430.txt)
```

Script file example 6

(Acquire a bandscan, measure stations of interest and put all results to ftp server. The FTP Upload must be set before, incl. local folder c:\fmscope\data\. The folders must be created before.)

```
bandscan.acquire
bandscan.savebitmap(c:\fmscope\data\bandscan.jpg)

ftpconnect
ftpput(bandscan.jpg)
ftpdisconnect

tune(89.1)
call(processdata)
tune(91.4)
call(processdata)
tune(92.2)
call(processdata)
tune(97.5)
call(processdata)
tune(104.1)
call(processdata)
stop

processdata:
setmode(0)
sleep(60)
modulationpower.run
sleep(900)
modulationpower.stop
modulationpower.savebitmap(c:\fmscope\data\pm%freq.jpg)
frequencydeviation.acquire
frequencydeviation.histogram(1)
frequencydeviation.savebitmap(c:\fmscope\data\hi%freq.jpg)
frequencydeviation.histogram(0)
frequencydeviation.savebitmap(c:\fmscope\data\dp%freq.jpg)
mpx.run
sleep(10)
mpx.stop
mpx.savebitmap(c:\fmscope\data\mx%freq.jpg)
setmode(1)
sleep(60)
rds.getdata
rds.getstatistics
rds.savedata(c:\fmscope\data\rd%freq.txt)
createreport(c:\fmscope\data\rp%freq.txt)

ftpconnect
ftpput(hi%freq.jpg)
ftpput(dp%freq.jpg)
ftpput(mx%freq.jpg)
ftpput(pm%freq.jpg)
ftpput(rd%freq.txt)
ftpput(rp%freq.txt)
ftpdisconnect

return
```

Script file example 7

(Permanently monitor the station, send email if there's no signal or no audio for more than one minute.)

```
tune(106.2)
setmode(0)
set(signal_counter)
set(audio_counter)

repeat:
getquality
send(?X)

if (%quality<3)
  inc(signal_counter)
  goto(stage2)
  endif
set(signal_counter)

stage2:
if (%tsmaxhold<25)
  inc(audio_counter)
  goto(stage3)
  endif
set(audio_counter)

stage3:
if (%signal_counter=5)
  call(send_email)
  endif
if (%audio_counter=5)
  call(send_email)
  endif

sleep(10)
goto(repeat)

send_email:
email.to(info@radio.com, luis@radio.com)
email.subject(FM Scope Message)
email.body(Failure detected on %frequency!)
email.send
return
```

Script file example 8

(Save stations from the bandscan to an Excel file.)

```
bandscan.acquire
set(stationindex,1)
set(filename,Bandscan %date %time.csv)
savetext(%filename,"Frequency";"Level [dBuV]";"RDS PI";"RDS PS"%cr)
rpt:
if (%stationindex>%stationcount)
  stop
  endif
appendtext(%filename,"%station.frequency";"%station.level";"%station.rdspi";"%station.rdsps"%cr)
inc(stationindex)
goto(rpt)
```

Script file example 9

(Measure stations from the bandscan, save histograms if there's enough of samples.)

```
bandscan.acquire
set(stationindex,1)
setmode(0)

rpt:
if (%stationindex>%stationcount)
  statusbartext(Done.)
  stop
  endif
statusbartext(Measuring %station.frequency %station.rdsps ...)
tune(%station.frequency)
sleep(120)
frequencydeviation.acquire
if (%totalsamples<20)
  goto(skip)
  endif
checkfilename(filename,%freq %station.rdsps)
frequencydeviation.savebitmap(%filename.jpg)
skip:
inc(stationindex)
goto(rpt)
```

Script file example 10 (Advanced users)

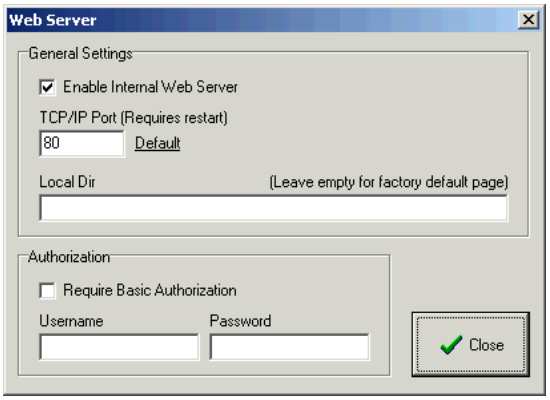
(Working with array – a set of variables whose names are created dynamically using another variable)

```
set(index,0)

rpt:
if (%index>9)
  stop
  endif

set(item%index,Item %index content)
textwindow.addline(item%index value is %item%index)

inc(index)
goto(rpt)
```

Web server

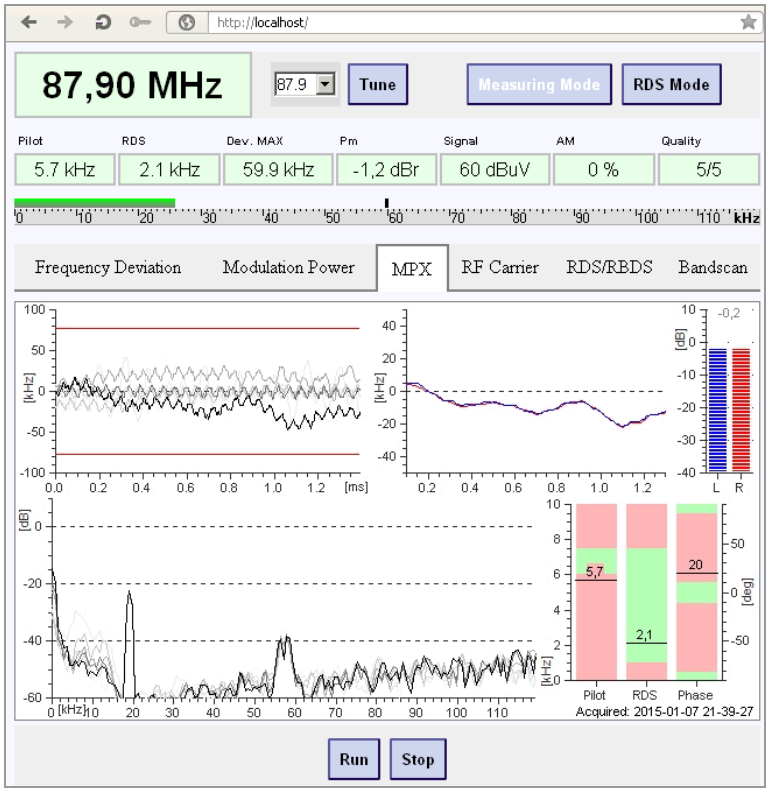
The software includes internal web server, the content is available to the operator through a standard web browser or even mobile device. The web server supports showing of special dynamic content as well as HTML forms (GET, POST) for setting variable content and controlling a script. Basic control is implemented without need of any script running. The web server is not intended for public presentation of the results and does not support PHP or ASP.

Before attempting to use the web server, it must be configured first in Options/Web Server:



Enable Internal Web Server – Enables the Web server.
TCP/IP Port – The port number on which the server provides the content. Default is 80.
Local Dir – If not empty, specifies the user web root directory on your local hard disk. Usually, this is the folder which contains the main file index.htm.
Authorization – The authorization should be enabled if the web server can be accessed from public internet.

Once configured, open the web browser and type the address http://localhost/ (for default port 80) or http://localhost:<port>/ (for other ports):



If the values do not update automatically, make sure that Online Update of Deviation and Signal is enabled in Options / Preferences / General and your browser supports JavaScript.

Hint: Following paragraphs are intended for those who know writing dynamic web pages.

Dynamic content

Real-time parameters can be referred to in the website through the use of dynamic tags. These tags are equivalent to the script dynamic tags and variables. Also the syntax is the same. When dynamic tags are placed in an HTML web page, corresponding actual values are sent by the web server when the page is served out. Syntactically, the dynamic tags are variable names prefixed by single % character.

The following files can include dynamic tags: .HTM, .HTML, .JS, .INC, .XML, .CSS, .XHTML

The user website is composed of standard HTML files, which may contain links to internal or external websites, Java Scripts, graphic files and more. Using the dynamic tags, the page can also be used to dynamically display and update measured values, script variables etc. For example, to display the current pilot level value, enter %pilot anywhere on the page, as in the following example:

```
<HTML>
<HEAD>
<TITLE>SAMPLE PAGE</TITLE>
</HEAD>
<BODY>
<h1>%pilot</h1>
</BODY>
</HTML>
```

When serving this home page, the web server replaces the %pilot string in the served page with the current value of that parameter.

Note: The web server cannot show any measured value which has not been previously received from the device. When serving the content, the web server typically does not update the values from the device but uses the latest values known.

Reserved addresses

Following addresses provide special content:

Address	Description	Example
/getvar/<variablename>	Returns the content of the specified variable (dynamic tag) in plain text format.	http://localhost/getvar/time
/getstr/<string>	Returns the string in plain text format, with all dynamic tags replaced by actual content. The string must be URL-encoded.	http://localhost/getstr/ The+time+is+%25time +and+date+is+%25date
/getimg/<imagename>	Returns the graph image specified in jpeg format. The image name can be one of the following: frequencydeviation, modulationpower, mpx, rf, bandscan.	<img src=”/getimg/mpx”>
/getimg/<imagename>/ <resolution>	The same as previous but you specify also the image resolution in pixels (width x height, without spaces).	<img src=”/getimg/mpx/ 640x480”>

Reserved variables

There's a reserved variable named 'webaction' which is used to perform basic control of the device. Once the website returns this variable via either GET or POST method, following operation will be performed, depending on the variable content:

'Webaction' variable content	Action equal to
H	Frequency Deviation / Acquire
P	Modulation Power / Run
p	Modulation Power / Stop
O	MPX / Run
o	MPX / Stop
D	RDS/RBDS / Acquire
A	Bandscan / Acquire
G	switching to Measuring mode
g	switching to RDS mode
S	stop current script
s	restart current script
frequency for example 91.9	entering the frequency and clicking on Tune button

For some operations, internal variable named 'webwaitingfor' indicates whether the operation has completed or not:

%webwaitingfor	Following operation has not completed yet
H	Frequency Deviation / Acquire
D	RDS/RBDS / Acquire
A	Bandscan / Acquire
F	tuning to a new frequency

Basic state of the FM Scope application is indicated to the website via variable named 'updating':

%updating	Meaning
bit 0	Modulation Power running (1) or not (0)
bit 1	MPX running (1) or not (0)
bit 2	Fast peak deviation bar indicator active (1) or not (0)
bit 3	Measuring mode (0) or other mode (1)

Interaction with running script

The web server provides not only the value viewing and basic control but can take control over a FM Scope script as well. The prerequisite is that the script processes variables passed from the web site. Typically, the web site provides a form for user input. Once the user (or JavaScript) submits the form data by either GET or POST method, the script running in the FM Scope will detect the variable content change and make corresponding operations. All parameters passed from the form are visible for the script under the same name of variable, i.e. the parameter content can be accessed by *%parameter*.

Summary: The web site cannot execute script commands directly but if a script is already running, the web site can control its flow by means of the variable content given by GET/POST methods.

Socket control

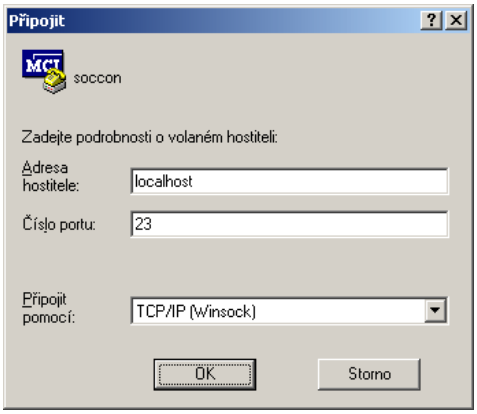
The socket control feature is intended only for advanced users. It's a simple method how to control the application from another via TCP/IP sockets. This function is however primarily not intended for remote control of the equipment (see section 'Connection' instead).
Before attempting to use this function its parameters must be set first in Options/Socket Control:

Enabled – Enables internal Socket control server.
Terminal Echo – If enabled, all incoming characters are sent back.
TCP/IP Port – The port number on which the server listens for a client.

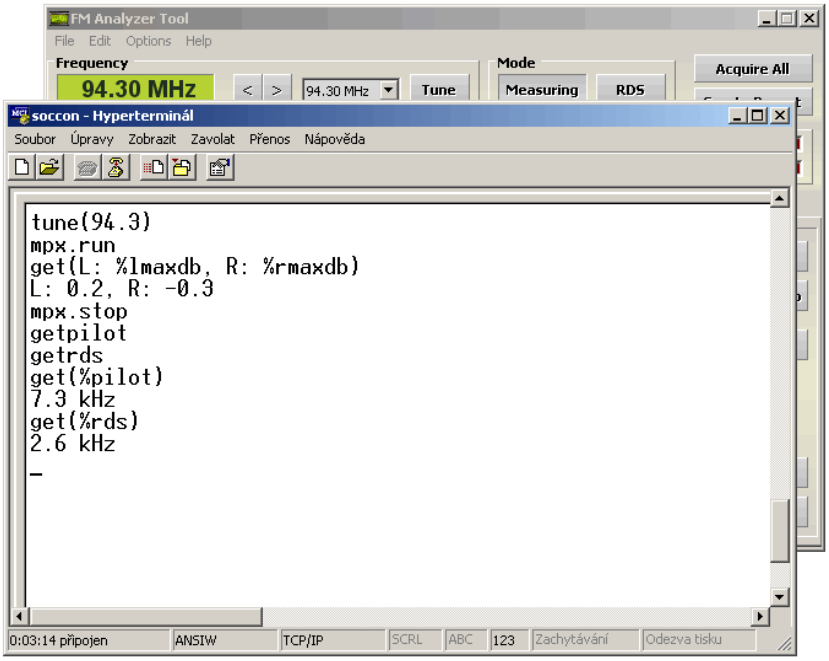
The Socket Control accepts all script commands and moreover it provides also backward channel with the aid of the command get (see the list of commands). Each command entered is considered as a separate script. If a script file is being processed, all commands entered by the Socket Control are placed in queue and processed afterwards. The exception from this rule is command +++ which breaks any running script.

How to start?

One of the best illustrations of use is to control the application from Windows Hyperterminal (or other terminal, like PuTTY). Run the terminal, select TCP/IP connection type and fill the server address and port.



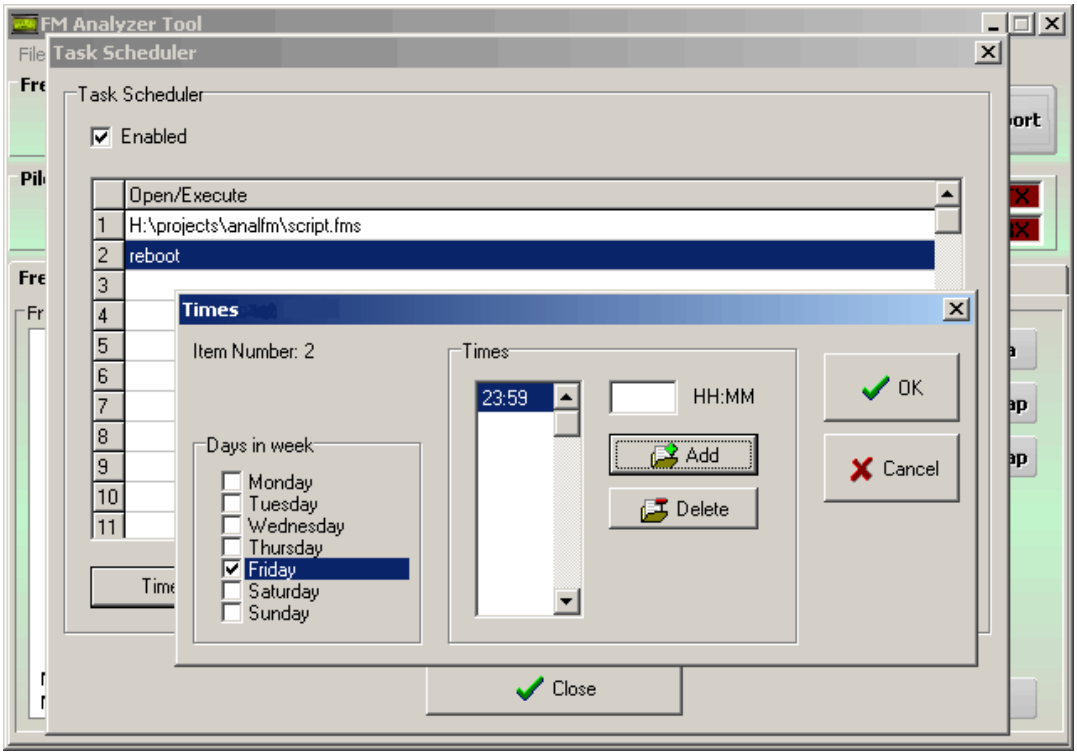
Click OK to connect. Make sure the Socket control feature is enabled and the application is running.



Task scheduler

Built-in task scheduler allows to schedule script files (*.fms) execution and any other application execution or document opening. You may also use it to restart/shutdown the PC, to send any string to the connection or to exit the application.

To open the task scheduler, select Options/Task Scheduler in the main menu.



Enabled – Enables the Task Scheduler.
Times – Allows you to specify days in week and times in the day when the task will be executed.
Delete – Removes the selected task.
Find File – Easy way how to find a file/application to be executed. This may be a script file or any other file.

These keywords are also accepted in the task line:
exit – Exits the FM Scope application
reboot – Reboots the PC
shutdown – Shutdowns the PC
send: – Sends any RDS command, for example SEND:096200*F

Tips

- Set read-only attribute for fmscope.ini to avoid unwanted configuration changes.
  The fmscope.ini file as well as the script variable content file is usually placed in local settings folder, for example:
  C:\Documents and Settings\[user]\Local Settings\Application Data\FM Scope\
- Any reports are welcome! Please send your suggestions or bug reports. It will help to create new improved version of this application.
- Visit the forum at http://pira.cz/forum/

Service Part

Firmware update

The FM analyzer has a firmware update capability. This allows easily implementing of new features. When a new firmware version is released, a special simple Windows application provides the firmware update. The firmware updates are provided at no additional costs.

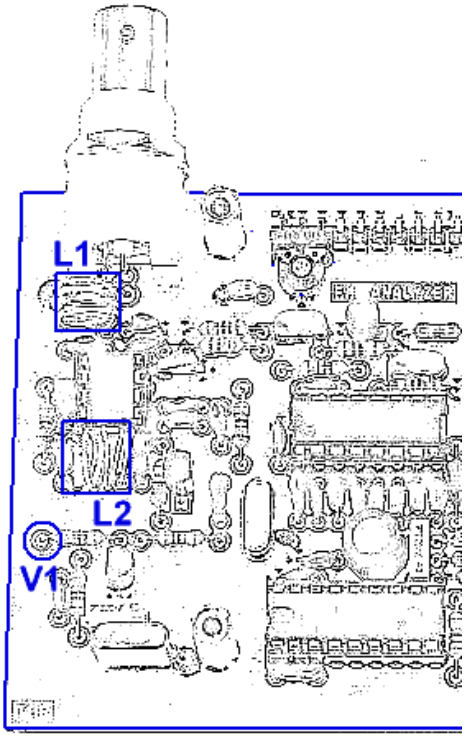
1. Connect the FM analyzer to any local COM port or USB port (P175).
2. Run the update utility, select the COM port and click Start! button.
3. Turn on the FM analyzer if not done yet.
4. The upgrade process is fully automated and takes about 1 minute.

Please refer to the web site for more information.

Don't forget to download also actual control software and manual with the new firmware! Keep all parts the same version!

Superheterodyne receiver ganging

This operation should make a qualified person only!
Under normal conditions there is no need to proceed this operation!
The device comes optimally adjusted from factory!
User should not touch the coils!



L1 – Antenna coil
L2 – Oscillator coil

V1 / Ut – Tuning voltage

1. Tune the unit to 108.0 MHz.
2. Adjust the tuning voltage to 4.0 V by oscillator coil. The tuning voltage tolerance at 108.0 MHz is ±0.1 V.
3. With the antenna connected tune any station in range 89.0-92.0 MHz and adjust antenna coil to the best (strongest) signal.

Annexes

Memory map

Address	Length	Content	Unit
01A	002	Actual receiver frequency raised by 1065	kHz*10
020	002	DIP switches (bit 0 = DIP0)	-
024	002	Pilot deviation	Hz*10
026	002	RDS deviation	Hz*10
028	002	Pilot to RDS phase difference	deg.
02A	002	ΔF MAX	Hz*10
02C	002	ΔF AVE	Hz*10
02E	002	Modulation power (linear)	1/100
030	002	ΔF MIN Hold	Hz*10
032	002	RDS PI	-
034	008	RDS static PS	-
03C	001	RDS PTY	-
03E	002	RDS status bits, bit 10: CT indicator, bit 9: RT indicator, bit 8: RT Type (A/B), bit 7: AF indicator, bit 6: TP, bit 5: TA, bit 4: MS, bits 3 to 0: DI.	-
040	020	RDS group counters (0a, 0b, 1a, 1b, ... 15b)	-
060	01A	RDS AF list	channel No.
07A	008	RDS EON PI (up to 4)	-
082	001	Signal quality	-
088	002	ΔF MAX Hold	Hz*10
08E	001	Amplitude modulation (0xFF = not available)	%
144	002	ΔF in last 50 ms time period (0xFFFF = not available due to noise)	Hz*10
146	002	Noise level averaged over 1 sec.	-
19C	040	RDS RT	-
1DC	008	RDS PTYN	-
1E4	001	RDS CT Hour	-
1E6	001	RDS CT Minute	-
1EA	003	RDS MJD	-
1EE	001	RDS RT+ group type	-
1EF	001	RDS RT+ status	-
1F0	001	RDS RT+ item 1 type	-
1F1	001	RDS RT+ item 1 start	-
1F2	001	RDS RT+ item 1 length	-
1F3	001	RDS RT+ item 2 type	-
1F4	001	RDS RT+ item 2 start	-
1F5	001	RDS RT+ item 2 length	-
1F8	001	RDS PIN day	-
1F9	001	RDS PIN hour	-
1FA	001	RDS PIN minute	-
1FB	001	RDS LIC	-
1FC	001	RDS ECC	-
1FD	001	RDS CT local time offset	half of hour

48C	002	Instant Modulation power (linear)	1/1755
4CE	001	Alarm - Silence detector ΔF AVE minimum	kHz
4CF	001	Alarm - Overmodulation ΔF MAX Hold maximum	kHz
4D0	001	Alarm - Overmodulation Histogram MAX At maximum	kHz
4D1	001	Alarm - Overmodulation ΔF AVE maximum	kHz
4D2	001	Alarm - Pilot minimum	kHz/10
4D3	001	Alarm - Pilot maximum	kHz/10
4D4	001	Alarm - RDS minimum	kHz/10
4D5	001	Alarm - RDS maximum	kHz/10
4D6	001	Alarm - Signal lost time duration	s*10
4D7	001	Alarm - Silence time duration	s*10
4D8	001	Alarm - Overmodulation time duration	s*10
4D9	001	Alarm - Pilot or RDS error time duration	s*10
4DA	001	Alarm - Alarm time hysteresis	s
572	0F4	ΔF Histogram	-

Important notes:
Lower byte is carried first (higher byte is placed at Address+1 for 2-bytes variables).
The Address and Length values are in HEX format.

SetProperty and ReadProperty options

Property	Value expected or returned
USPTY	Integer value, 0 (disabled) or 1 (enabled)
OnlineUpdate	Integer value, 0 (disabled) or 1 (enabled)
ScanRDS	Integer value, 0 (disabled) or 1 (enabled)
AlwaysCheckRDS	Integer value, 0 (disabled) or 1 (enabled)
InvertColors	Integer value, 0 (disabled) or 1 (enabled)
HighContrast	Integer value, 0 (low) or 1 (high)
DeviationLimit	Integer value, in kHz
DeviationTolerance	Integer value, in kHz
PmLimit	Floating point value, in dBr
PmTolerance	Floating point value, in dBr
ExecutionSpeed	Integer value, 0 (lowest speed, 1 line / sec.) ... 4 (highest speed, 100 lines / sec.)
DebugMode	Integer value, 0 (disabled) or 1 (enabled)
LogErrors	Integer value, 0 (disabled) or 1 (enabled)
NoBreak	Integer value, 0 (disabled) or 1 (enabled)
HistogramBitmapWidth	Integer value, in pixels
HistogramBitmapHeight	Integer value, in pixels
PmBitmapWidth	Integer value, in pixels
PmBitmapHeight	Integer value, in pixels
MPXBitmapWidth	Integer value, in pixels
MPXBitmapHeight	Integer value, in pixels
RFBitmapWidth	Integer value, in pixels
RFBitmapHeight	Integer value, in pixels
BandscanBitmapWidth	Integer value, in pixels
BandscanBitmapHeight	Integer value, in pixels
OthersBitmapWidth	Integer value, in pixels
OthersBitmapHeight	Integer value, in pixels
DetailsInGraphs	Integer value, 0 (disabled) or 1 (enabled)
PmBoundaryMin	Integer value, -12 ... 11
PmBoundaryMax	Integer value, -11 ... 12
PmXAxisLength	Integer value, 1 ... 120, in minutes
WatermarkEnabled	Integer value, 0 (disabled) or 1 (enabled)
WatermarkText	Text string
WatermarkSize	Integer value, 0 (first option) ... 8 (last option)
WatermarkPosition	Integer value, 0 (first option) ... 2 (last option)
TrayIconHint	Text string (can't be read by readproperty)
StatusBarText	Text string
FTPHost	Text string
FTPUserName	Text string
FTPPassword	Text string
FTPRemoteDir	Text string
FTPLocalDir	Text string
FTPPassive	Integer value, 0 (disabled) or 1 (enabled)
SMTPServer	Text string
SMTPFrom	Text string
SMTPRequiresAuthentication	Integer value, 0 (disabled) or 1 (enabled)
SMTPSecureConnection	Integer value, 0 (disabled) or 1 (enabled)
SMTPUserName	Text string
SMTPPassword	Text string
MySQLServer	Text string
MySQLDb	Text string
MySQLUserName	Text string
MySQLPassword	Text string